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ARCHITECTURE BECOMES MUSIC



THEORY

As abstract art forms based on rhythm, proportion and harmony, architecture and music share a clear cultural lineage. Now, through digital expression, architecture can attain new heights of creative supremacy

'All art' Walter Pater famously observed in 1877, 'constantly aspires towards the condition of music' Why the music envy? Because, the standard answer goes, in abstract music the form and content -- or in its case the sound and sense -- are one integrated thing. Pater's aphorism became a good prediction of the Zeitgeist and the goal for abstract art in 30 years as the painters in Paris and elsewhere pursued a kind of visual equivalent of musical themes, and Expressionist and Cubist architects followed suit. Indeed architecture as 'frozen music' had a long history of tracking its sister, the parallel art of harmonic and rhythmic order.

Many qualities unite these two art forms -- and quite a few make them different -- but it is the former I find compelling today. Their shared concerns can be seen in ceremonial architecture from the ancient Brodgar Stone Circle to concert halls, in structures that heighten the senses and make one perceive more sharply and emotionally. In an era when museums and other building types emerge as a suitable place for musical ornament, and when expressive shapes can be produced digitally, architecture could reach its supreme condition once again

and become its own particular kind of music.

The cosmic codes

Since at least the sixth century BC, music and architecture have been intimately joined by a cosmic connection, the idea that they both are generated by an underlying code. This order, revealed by mathematics and geometry, was first espoused by Pythagoras who lived in southern Italy, and it led to many Greek temples designed on proportional principles revealing not only supreme beauty but 'the music of the heavenly spheres' -- either God or nature. The idea was so appealing that many later designers tried to capture the notion with new materials. For instance, as Rudolf Wittkower argued, Renaissance architects saw the cosmic connections in simple ratios such as 1:1 (a sound repeating itself, or the architecture of a square room), and 2:1 (the octave, a string doubled or halved in length, or in building the double-square front of a temple).

So far so simple, one could explain these analogies by vibrating strings and, as Pythagoras was supposed to have heard, a blacksmith hammering away with instruments of different size. He and others compared the harmonic results to the rhythms of a well-proportioned building, and the code of musical architecture was born. Perfect geometrical figures were equated with perfect whole numbers -- 1, 2, 3, 4 -- and then with the perfect harmonic sounds they produced (called 'the perfect octave, the perfect fifth (3:2); the perfect fourth' (4:3) and so on.

The Greek temple epitomised such connections for another reason, it was a building type created around musical performance, where the perfect form of the stones literally reflected the sounds of dancing, of flute playing and singing in procession. Its columns and intercolumniations created a steady beat of solid/void that was particularly staccato when seen head-on: A,B. These rhythms were conventionalised and named so the architect could speak the dimensions.

He might say, 'Let us try the Pycnostyle, the fastest beat of intercolumniation.' The By style and Eustyle were for middling speeds, and Diastyle and Araeostyle used for the slowest, stately rhythms, but he would have been something of a pedant to have gone through the list of options. The fact is that virtually no layout drawings of Greek architecture or music survive (though like the Egyptians, architects must have scratched plans on the stones before construction). We do not even know the notation systems of either profession, and it may well be that the composers of both arts 'spoke their creations' like little gods. This verbal creation was more likely in music, because it was taught as one of the seven great arts and

committed to memory by hard training: geometrical ratios then united it to ceremonial architecture.

In spite of this geometrical harmony, differences between the two arts emerge which are as instructive as the similarities. When the temple columns are seen more obliquely, the ornamental fluting becomes like a solid wall of vertical rhythms, and these accelerate even further with a tighter angle. How different this is from a symphony which cannot, ordinarily, be sped up or slowed down by the perceiver; or read backwards as architecture can be from the exit; or top-down as with a skyscraper.

Architecture is a variably perceived art. It is correctly experienced from several distances and speeds of movement, a property exploited by Peter Eisenman with another staccato composition, his monumental field of separated cubes in Berlin, both an abstract urban pattern and a memorial. Like the Greek temple, it induces the feeling of finality by the absolute contrast between sunlight and blackness. As one explanation for the design, Eisenman described a mood of fear that he experienced when lost in an Iowa cornfield without any cues of orientation or scale. His endless, undulating ground of large concrete blocks naturally expresses this feeling of panic, when one descends into its agoraphobic abstraction. Like the Greek temple, it makes effective use of an isolated, staccato beat -- Light/Dark, A/B -- but now to send another message: presence/absence. This meaning is further emphasised as you see people suddenly appear and disappear randomly, as they walk through the Holocaust memorial, coming into view suddenly only to vanish. Such naturalistic meaning is as violent as a trumpet blast followed by stillness, or a shriek by silence, and it exploits another convention common in music. Just as the funeral dirge has a remorseless build-up to the inevitable declining notes, so the memorial's blank coffins thump up only to steadily trail away, like the descending line of a dirge.

When music and architecture use such natural and conventional meanings in so simplified a form they raise emotions to a high pitch. The Gothic cathedral proves the point, especially while music is being performed on the inside.

By the year 1200 architectural drawing and musical notation were more common, and a few examples of both survive. The composer Pérotin, working at Notre Dame in Paris, introduced a notational system of long and short notes so he could signal basic rhythms -- Dum-ti, Dum-ti, Dum-ti, Dum -- just as Gothic architects were working out complex alternate bay rhythms -- A,b, A,b, A,b, A. Note in this example both music and building start here on a long stressed element (Dum or A) and then skip forward on the half-beat (ti or b). Note the nave elevation

of Notre Dame where these rhythms are marked in several ways, such as the engaged colonnette on every second pier (which also marks the sexpartite vault above), A,b.

The parallels between architecture and music are extraordinary. Pérotin and his musicians were working out the harmonies of three and four melodies stacked above each other. These often moved in great blocks creating harmonic chords pleasing to the ear. Architects were also stacking three or four levels (arcade, triforium, gallery, clerestory) in equivalent chords pleasing to the eye. The architectural melodies did not run in as strong opposition as the music. They were smoothed along and ran parallel in horizontal chunks; but there are decorative elements that give the architecture a subtle counterpoint.

These sub-rhythms are particularly evident if you examine the evolution of Gothic across time, as shown in the diagrams. These drawings bring out the way four levels of Noyon and Laon are synthesised into the classic three, at Chartres, and then further squeezed and stretched upwards, as the wall dissolves in ever greater light at Reims and Amiens. Little mouldings buzz along the horizontals that accentuate the melodic lines, while more and more colonnettes whiz up the verticals accentuating the harmonies. The great architectural dialectic of horizontal versus vertical forces starts here and culminates in the early skyscraper.

The musicians of Notre Dame loved the architectural polyphony, and even outperformed it. Their experiments with four voices, and simultaneous clusters of chords, are more complex than the nave elevation and much cheaper to build in music than stone. They emphasised harmonic ratios such as 3:2 (called with explicit Godly overtones, 'the Perfect Fifth') and 4:3 ('the Perfect Fourth') and drew them on lined bars as if they were the cornice lines drawn by the master builder. Again consider the analogy where it works and breaks down. The five horizontal lines of musical notation -- the staff -- and their four spaces between are roughly like the parallel horizontal 'melodies' of the four-part nave elevation, reading left to right as one approaches the altar: except the musical melodies cross the five lines, while the 'chords' of architecture stay mostly locked between the string courses.

Pérotin and the musicians of Notre Dame pushed on to ever more subtle harmonic relationships of 5:4 ('the Major Third') which was more upbeat and happy than the poignant ratio of 6:5 ('the Minor Third') which became common to the melancholic laments, their Miserere. There is nothing exactly equivalent to these heightened emotions of happiness and sadness in the architecture except, maybe, the stained glass and gargoyles, or an outbreak of fan vaulting, or any artistic accent so essential to mood and meaning.

The phrases in scare quotes ('Perfect Fifth') are hard to learn at first because they refer first to physical notes on a keyboard and only afterwards to the underlying ratios and sounds you hear. But the insights and terms have also led to subsequent innovations in Western harmonics right up to the present, and even become standard ideas for global music. And one could point out that the jargon of architectural relationships, the 'triforium' and 'colonnets' or today the 'spandrel' and 'I-beam' are equally esoteric, but important for the deeper effects.

This raises an important point about perception. Great music and high architecture are sometimes most appreciated when they are imperfectly understood, which is not to say that the composers of each were not aware of their craft. But it is to say the emotional experience of each is very different from the analysis, a point brought out when you enjoy a building inattentively as part of a background (the argument of the philosopher Walter Benjamin and mass culture theorists).

Again, examine the contrast between architecture and music in Notre Dame. Where do you stop, look and listen hard, as you are supposed to do with a symphony? Probably where you rest on a seat and contemplate the space of the nave as it rushes to the altar, an experience quite different from viewing the side elevations. The first are solid and stone relationships set in sequence, now it is the void and space seen as a whole, and contemplated with the entire meaning of the church (the heavenward gesture, the structure like a communal 'boat', and associations such as primeval forest). So in this holistic grasp the two arts seem opposed. We take the space in at a glance, while music is necessarily experienced in parts over time, and the two media are as opposed as light waves from acoustic waves. Such oppositions have been emphasised since the 19th century, and more of that later; but what about another positive link beyond harmonies and proportions?

Above all it is the heightening of emotions which in music, and with cathedrals and concert halls, is a common goal. Musicians are often taught the six basic moods, and modes, they can stress -- sadness, joyfulness, fearfulness, tenderness, love and anger -- and emotional articulation could be denned as a purpose of music. With architects today it is sometimes the reverse, especially when they are taught to avoid explicit moods and attain a neutral background; or avoid any explicit meaning. But in spite of this they still respond to the funeral dirge and dance music.

The ultimate holistic experience? Sydney Smith famously gave the secular definition of

heaven as 'eating foie gras to the sound of trumpets' a kind of super-synthaesthetic peak-experience to which an atheist architect added 'but only in the nave of Notre Dame', a waspish answer that brings out the power of emotional architecture. You only have to listen to monks chanting in the 'acoustic ears' of Le Corbusier's Ronchamp to hear the point; or, less grandly, to sing aloud in a tiled shower. The reverberation of overtones captures the synergy.

The cosmic codes that are performed by such music and architecture do not require beliefs so much as the ancient idea that we are tuning-forks for holistic experience. With the rise of modernity, however, this tradition of anonymous, collective design -- and musical composition -- was partly displaced by the named architect and composer, sometimes a celebrity. New notational systems aided this development after 1500 along with new materials, new instruments and the emphasis on the individual creator.

The plurality of new codes

In *The Story of Music*, 2013, Howard Goodall tells this tale of expanding virtuosity and the composers who became public figures, impresarios such as Vivaldi. As the example of Michelangelo shows, the same pattern occurred with celebrity artists and architects. Their personal styles and motifs competed with the traditional modes, which then started to feel stiff and old-fashioned. For every Monteverdi who invented new madrigals and forms of opera there was a corresponding Borromini, the author of new spatial concepts and formal moves in architecture. Competitive innovation has gone on since the 17th century and today, in architecture at any rate, we have a bloom of personal styles dominating the scene, albeit working within various modernisms. Reyner Banham called Le Corbusier 'The Last Form Giver' in 1968, and foresaw the end of this tradition, but his prediction proved wrong.

From Ando to Zumthor, from Eisenman to Gehry to Hadid to Libeskind to Wolf Prix and back again; from Koolhaas to Herzog & de Meuron, or in engineering from Calatrava to Balmond; from the recent generation of digital designers, the '90s Blobmeisters such as Greg Lynn to the 2000s Parameisters such as Patrik Schumacher; from curved to angular fractals wherever you look new languages of architecture are proliferating, idiolects are defined, and form-givers flourish. Critics understandably chide these Starchitects, but the jibes and moralising have not halted their proliferation any more than did Banham, and they miss an opportunity to see the growing genre in a different way and explain it to the public.

Besides, fame and notoriety are less valuable than the new architectural music, and this burgeoning movement asks to be criticised as such, in its own terms. Some designers have

explicit music in mind: Libeskind, Gehry, Pritz have composed parts of their buildings with inspiration from Schoenberg and '60s pop music; while others are pushing explicit compositional forms: Eisenman, Koolhaas and Hadid. Let us return to where architecture and music have similar intent: extreme emotional arousal.

Extreme emotion and neutrality

When he was 24, Le Corbusier experienced the Parthenon in vivid metaphors -- 'a brazen trumpet that proffers a strident blast. The entablature with a cruel rigidity breaks and terrorizes. The Parthenon, terrible machine, pulverizes and dominates everything for miles around'. Is it heroic angst or piercing beauty? A heightened response to the Parthenon often occurs -- Louis Kahn also described his rapt experience here -- and it partly depends on the dramatic approach and journey up to the Acropolis. Music, as we will see, has its counterpart to this drama in the progression of chords up to a climax or cadenza, or down to a 'home'. Le Corbusier's violent metaphors, the temple blasting out like a 'brazen trumpet', or gun, epitomise the response to so much Greek architecture while the opposite architectural emotion -- serene, harmonious peacefulness -- is evoked by the Taj Mahal, especially when seen at dawn through the morning mist.

Heroic anger and optimistic passion typify much martial music just as competitive joy epitomises the duets of Mozart, which were often written along with a libretto dramatising the battle of the sexes. Stereotype and genre lie at the base of both music and architecture -- the funeral dirge taking place in a mortuary chapel, a pop concert in a stadium -- and composers in both arts have to wrestle with the entropy of cliché, which always threatens to devour their reputation. Daniel Libeskind, who pushes architectural emotion towards melancholy and fear, sometimes succeeds. His Berlin Jewish Museum is the supreme example of memorialising sadness, terror, the Cool Horrific. It is even more powerful than Eisenman's great work, to my mind, because it calls on so many more contrasting tropes. The zigzag path one walks on is set against the Holocaust void one cannot enter but always cross; the slashes and cuts in the exterior grey zinc contrast with the tilt of the white concrete stumps (out of which willows emerge wafting a peaceful note). Oppressive concrete walls set off liberating views of the sky, and so on through the play of violent diagonals versus a background of neutral grey. Libeskind, a trained musician, who has designed a series of architectural Choral Works, is obviously sensitive to analogies between the two fields, and the visual tropes I have mentioned have their musical counterparts.

For instance, his long thin stairway, punctured by angular struts and underscored by dark stone, is a natural echo of the mood created in Albinoni's Adagio in the key of G minor. This

has a descending base-line that repeats again and again -- 'going down, going down' as it were a naturally expressive form of sadness, as stereotyped as using a minor key in the context of death.

For the museum addition, Libeskind was particularly inspired by Arnold Schoenberg's last opera, the unfinished *Moses and Aaron*. Schoenberg, the quintessential modern 12-tone composer, breaks off his opera at the point where Moses and Aaron are unable to complete their mission with the people of Israel: 'Oh word, thou word that I lack!' Moses laments his inability to lead the people to the promised land. The building's central void expresses this inability to speak the word, while the zigzag plan shows Aaron's determination to go forward, nevertheless. Few false notes are struck in this memorial to the Berlin Jews. The public can feel the stereotypes without the corruption of cliché, because they are transformed in slight ways and subservient to the meaning of each part in the journey.

What is the architectural opposite of angst -- joyful excitement? That is one of the stereotypical moods hardest to sustain. As every wedding march hopes to achieve, as every Olympics opening ceremony is required to produce, joyful-happiness is a trickster. It comes best as an uninvited guest, a by-product of something else, typically as a result of pure, formal invention. A case in point is Sauerbruch Hutton's museum in Munich which became a dazzling work of Op Art because of road noise that had to be deflected. The functional requirement led to a visual blur that dances around in front of your eyes and even changes colour as you approach and recede. On a musical level it is a type of visual jazz, or mad pizzicato, or extreme blending of many tones called chromaticism. On a visual level it is an optical illusion of pixellations; as the observer approaches and backs off the small tones converge into larger areas of identity, like the canvasses of Seurat and the Pointillists. The digital age has an aesthetic obsession with the 'all-over blend' and the 'seamless joint', the integrated gesture.

In the 18th century, however, extreme contrast was sought. As the concerto turned into the symphony, composers such as Mozart juxtaposed joyful play versus seriousness. Underlining this opposition, the whole orchestra was set against a soloist, or -- with Beethoven's signature trope -- the loud flourish was followed by absolute silence. The last was something so emphatically missing as to turn a void into an architectural solid. Many architects since the 1970s have been emphasising the 'positive figural void' -- particularly Michael Graves and James Stirling -- but in practice no one has achieved it with such sheer cataclysmic pleasure as Wolf Prix of Coop Himmelb(l)au.

Most of his large public spaces have a highly sculptural figure absorbed into and yet contrasted with a background massing, particularly the roofline. A case in point is his BMW headquarters in Munich, a showroom amplified into a frozen swoosh of polished gun-metal. If the silver streak of automotive movement ever needed expressing it is found here. At the intersection of two high-speed roadways Prix's favourite motif of the double cone announces the main theme like a Beethoven flourish. But it is then modulated in a horizontal direction very effectively, to slide up and down in counterpoint with the flat line above. The contrasting and smoothing of elements work to great effect. The building has some explicit musical inspirations, just as does the contemporary Frank Gehry's Music Experience Building in Seattle, which is based on Jimi Hendrix and '60s rock music.

'I want to build string sound', Prix has said on occasion, and one rhetorical flourish recurs in his work, the sliding glissando. This sweeps over every material and form, blending them to keep a unified experience, while counter themes erupt here and there -- dissonances and violent shrieks. A 19th-century composer might have recognised the Sturm und Drang. Prix pushes improvisation hard as does his favourite Rolling Stone, Keith Richards, and like his exemplar, he contradicts himself.

An article on the Rolling Stones (Rolling the Sky, 1995) starts with the trumpet flourish: 'Architecture has absolutely nothing to do with music,' and then proceeds to enumerate a few good analogies such as, 'the way that Keith Richards plays rhythm guitar generates an energy that can be compared metaphorically with the energy progression of our constructions'. Particularly inspiring for Prix is the 'open tuning' of Richards obtained by removing the sixth string on a guitar in order to slide and glide even more, and to achieve fresh and unheard-of chords, hanging in space. The interior of Coop Himmelb(l)au's BMW-World slides around like the electric guitar and becomes another explicit metaphor for the architect. Such 'open tuning,' as it is called, turns into another of Wolf Prix's favourite ideas: the 'open space' for the Open Society. That was also the underlying dream of both the philosopher Karl Popper and the '60s student movement, and a large communal open space is found in all Prix's iconic architecture.

But the opposite of these pyrotechnic gestures, an understated architecture which manages to be interesting, is just as hard to bring off as understated music. Countless architects today aim at minimalism and what was called in the '60s 'businessman's vernacular'. Other competing modes of neutrality, Contextualism and the Neo-Georgian, are just as prevalent as Default Modernism, and together they raise the nagging question of conformity in architecture and whether there is any musical equivalent (except muzak)? Not Philip Glass,

nor John Adams; and I cannot think of any equivalent today of the two Bachs, who knew how to compose superior background fugues that transform mathematical patterns.

Creative background art raises another perplexity. Architecture has a required flip-mode that seems to be unique, and appreciated for so being. It is admired for being an artistic foreground but, with a shift in perspective, it flips into the background and becomes valued as urbanism. This change is not demanded of sculpture, or painting (unless a Tiepolo ceiling), or music (unless performed for special circumstances). The flip mode as contextual counterpoint will be considered next, but there are several designers who have built a background contextualism that still remains interesting, and relevant ecologically: Alison Brooks, Bill Dunster at BedZED, and above all Alan Short, who has worked at impossibly constrained sites with low budgets. For instance, his building for Slavonic studies, in a traditional London brick context, produces a low-key music. It manages to squeeze extra floors and numerous eco-requirements into a streetscape while also giving an understated rhythmical complexity that enlivens the long city block: vertical, horizontal and even diagonal patterns of movement.

Meaning, rhythm and force

Architecture and music thus are not only supremely emotional, at moments, but semantic and meaningful at other times. It has probably always been so, but since at least the 16th century, music explicitly has employed pictorial and programmatic themes referring to nature's moods, such things as rain storms and mountain ranges. Musical genres, as mentioned, developed their special themes for weddings, funerals, making love and war, all the modes and stereotypes that have been transformed from the time of the troubadours to the Beatles. Such pictorial and symbolic music reaches its greatest height with early Stravinsky, although he later disputed the idea.

His *Sacre du Printemps*, 1913, uses Russian folk tunes and martial drumbeats to personify the aggressive rhythms of nature and city life. Here he collages themes together as discordantly as any Cubist, and uses dissonant accents like a 12-tone composer. But unlike the atonal musicians, Stravinsky keeps a compulsive forward movement to his ballet music, by shifting emphasis from one agent to the next -- from rhythm to theme to progressing chords. Music must provoke our expectation to want the next moment. Call this latent desire the 'time-imperative' of the dramatic arts, those that unfold in a sequence of time. Information Theory has shown how one momentary perception builds up an expectation of the next moment, and although this forward movement can be resisted and frustrated for short periods, boredom sets in when there is no overall pattern or narrative. Stravinsky showed

with *Sacre* that the time-imperative could be satisfied by a quick change from tonality, to rhythm, to tune, to orchestration -- any driving pattern as long as the force goes forward compulsively.

With his *Rite of Spring* plucking violins in *pizzicato*, rhythms pick up the stirrings of primitive nature as it grows in springtime. This first section is named by the composer as *Adventure of the Earth*, and the Earth has never been more saturated with sexual energy as it incessantly rebounds into life. The French horns and cellos blow and saw in synchrony with a steady beat *chum chum chum chum chum chum*, followed by violent contrasts up and down like a pagan ritual, with screams followed soon by the soft reassuring note of a single flute. The whole *Sacre* is pictorial, which is one reason that *West Side Story*, many James Bond themes and much movie music has derived from it. For my money *The Rite of Spring* is simply the best abstract and figurative, cosmic and traditional music ever composed.

But Stravinsky might have disagreed. He famously wrote, in his 1935 autobiography, a classic version of the abstractionist dream that has been quoted many times: 'I consider that music is, by its very nature, essentially powerless to express anything at all, whether a feeling, an attitude of mind, a psychological mood, a phenomenon of nature, etc.' In effect, music is essentially just notes, chords and complex sound experienced over time. On a reductive level and for a creative artist in any field, such formalism has a truth and is understandable; but as Stravinsky perfectly well understood (and mentioned), it is not how listeners hear music. Perception is doubly-coded by form and content, and it is why learning and intelligence grow by connections between the two areas.

I emphasise the point of double-coding (common to all semiotic systems) because it challenges Walter Pater's aphorism -- the singular unity of form and content he finds best expressed in music -- and because many architects still labour under Stravinsky's (and Kandinsky's) hope for abstraction.

Jacques Herzog has said, 'A building is a building. It cannot be read like a book. It doesn't have any credits, subtitles or labels like a picture in a gallery. In that sense, we are absolutely anti-representational. The strength of our buildings is the immediate, visceral impact they have on a visitor.' Visceral impact they do have, but Herzog & de Meuron's buildings are indeed at the same time 'read like a book', and many other things besides including rhythmical music. Consider their *CaixaForum* in Madrid, a contextual collage of surrounding buildings and an old brick electricity station on the site.

Strong horizontal contrasts divide the collage into three basic voices or four or five melodies (depending on the reading). Rusted cast-iron crowns the top, the middle is brick, and the bottom is a black, voided ground floor, which amounts to a violent Beethoven silence. The basic A/b bay rhythm unifies the volumes and blank windows vertically, and this vertical emphasis is amplified by the volumes at the top. At this restaurant level the building opens up with mashrabiya grills, a recollection of Spain under the Moors, but in musical terms it is a cadenza culminating each chord (and giving a background buzz, what is called a musical 'drone'). Patrick Blanc's Vertical Garden to one side is also stressed with an upwards and diagonal emphasis. But it is Herzog's 'visceral impact' of the large contrasting blocks of colour and material indeed all the primitive themes -- that are reminiscent of Stravinsky's violent musical contrasts, at least to me. And like other readings between architecture and music, this will show some themes in common and some differences.

As often pointed out, a scientific analogy between two things is good if it is reduced to one or two qualities of comparison, whereas a cultural analogy can be better for revealing many parallels, as long as the differences are acknowledged. With columnar and window architecture, with buildings that have structural bays and tectonic articulation, the rhythmic parallel to music is narrowly scientific and precise. While it is true relationships change as you move through a building, you can stand still and read the facades of a bay like a musical score, one of the great pleasures of traditional architecture. Even more musical in rhythmic complexity and delight is the Grand Canal in Venice, which can be experienced as one long symphonic transformation of related themes.

Edouard François, at the Hotel Fouquet, Paris, has been forced by building codes to adopt traditional elements, but he has transformed them into new syncopated rhythms. While the conservative arrondissement demanded a Haussmannian architecture of five storeys, the hotel management demanded an eight-storey structure with picture windows for tourists. It sounds impossible, but the contradictions are threaded through each other to erupt in an automatic print-out. The result is contextual counterpoint, at once beautiful, funny and truthful.

What makes it more contrapuntal is that the five superimposed voices are worked through vertically as interesting harmony and dissonance. It is worth studying the analytical diagram to appreciate the skilful syncopation. The horizontal divisions can be seen as five melodic lines, and the vertical bays as harmonic stresses. In medieval and Baroque music, counterpoint is appreciated as the weaving of voices so they first answer each other and then harmonise in a key or cadenza. Also with François's facade the simple bay rhythm of

A/b/A/b is emphasised by the superimposed blind windows on three floors, the top oeil de boeuf, and the repeated wall spaces between.

So far so traditional, but then the expected steady beat -- de-dum, de-dum, de-dum of melody 1, on the ground floor -- is answered by the syncopation of the picture windows on the first floor. These are out of phase with the A/b rhythm, sliding across the b-bay creating a kind of de-dum (ti-slide) or glissando. This is an extraordinary move, and to further emphasise the contradictions required of him, the building is interrupted, amusingly, at the ends. Because the hotel is inserted into a pre-existing context at several points, Francois starts and ends his rhythms with a half bay (one-half A). This transitional joke is like the architectural 'cut-line' on a drawing. It announces gently 'the Haussmanian wallpaper starts here and ends over there'. It sets the theme for the other interruptions: the picture windows, the fire hydrants, the cash points, the large utilitarian doors and windows of the rusticated ground floor. These functional necessities are also carried out in tones of silver and grey; and the Haussmannian patterns are continued but now in metal. How droll, the consistency of style with inconstant material. It gives us a new oxymoron 'High-Tech syncopated with Beaux-Arts' -- beautifully tooled and consistent as a new form of architectural music.

Are musical chords like space?

The parallels I have been pointing out between music and architecture -- rhythm, emotion, meaning and the stereotype of genre -- are well known and accepted. One comparison, however, is contentious: the equation between the spatial and time arts. Music has always been known as an art of time, whereas only in the last 150 years has architecture been claimed as the art of space, even more than sculpture. From Sigfried Giedion to Bruno Zevi (by way of Frank Lloyd Wright and Le Corbusier), most critics and architects have insisted on the point. But there is one big mismatch. Music must be experienced in a linear sequence, while architecture is taken in three-dimensionally at a glance, or holistically, as Gottfried Semper averred; and it is even moved through as a series of whole pictures. Architecture does not move in time, even Futurist architecture does not move. This initial divergence between music-time and architecture-space becomes all the greater because they are experienced through wholly dissimilar organs; and also light waves versus sound waves. But consider the counter argument.

All percepts are made one after another. In particular, we read a space or a painting with shifting eyes that move in time. This fact begins to bring the two arts back together, a connection made deeper by the holism of experience itself and the further truth that a time-dependent expectation underlies all dramatic experience. We project the future onto the

present, the next phrase or chord onto music, the next room inside a building -- all the arts aspire to this condition of drama.

At the neurological level, further parallels exist between time and space experience. Cognitive studies have shown we are a bit like bats, especially when moving in a dark environment with reflective surfaces. When sounds bounce off highly reverberant materials, we can 'see through hearing', especially if we clap our hands, a fact well-known to the blind. As brain-scans have shown recently, music opens up the equivalent three-dimensional world inside our heads, the area of sight. Stereophonic systems exploit this aspect of hearing, as they open up a room to our imaginative projection -- a picture of space or the plan of a building; or the structural layout of a symphony.

Polychoral music took advantage of this spatial sense in the Gothic period, for instance at St Mark's Cathedral in Venice where different choirs were placed across from each other. Such opposition works well for placing different instruments that seem to expand the space further in the mind, a counterpoint Frank Gehry and Pierre Boulez have exploited recently, spatial hearing-as-seeing.

The obvious place where these parallel arts meet is the concert hall, and the metaphor 'space as chords of sound' turns into an expressive, petrified music. Since the Expressionists, and then Hans Scharoun's Berlin Philharmonic Hall of 1956, the idea of acoustic generated architecture has become a dominant metaphor. Scharoun designed what he called 'vineyards of people' -- and surrounded them with forms which reflected and at the same time dampened the sound. This trope has been adopted by Moneo, Piano and, particularly successfully, by Gehry at his Disney Hall. In this pulsating room, it is as if the listeners were inside a giant, wooden cello vibrating in sync with both the musical chords and the architectural space. Similar curves are used on the outside as well. So the whole building becomes a mixed metaphor of billowing sails and acoustic reflectors, one pulled together by large, rhythmical chunks -- like the simple block chords that Beethoven contrasted in his symphonies.

This 'space-music' is overpowering. It has certainly inflated critical metaphors (and mine), but is there anything more than that -- that is, a deep connection between harmonic chords and architectural space? I think there is, especially when they are both used in a dramatic way, in a sequence that leads somewhere.

Take the typical passage through an Egyptian temple complex. This is a natural drama of

discovery as elements become smaller, darker and more meaningful; or the supreme architectural experience I have already mentioned, the journey up the Acropolis to the Parthenon. Both are examples of the 'architectural promenade' that Le Corbusier made the hallmark of his work. One musical equivalent of this promenade is, for instance, a song in the key of C which is repeated, then transformed, then moved away from the base key in order to finally return. Musicians use an architectural metaphor to describe this journey -- 'the tune has a sense of going home'. A typical symphony will drive an organisational idea or leading chord to its culmination, and composers refer to this overall time-structure as its 'architecture.' So the parallels work both ways.

To emphasise how powerful the movement of chords can be, Howard Goodall adopts a kind of metaphorical overkill. He speaks of how, during Newton's time, musicians conceived the law of harmonic progression as having a sense of 'gravity'. One chord is attracted or repulsed by another, as if 'magnetised'. The power of chords increases visually as triads 'meld together like good colour combinations'. So strong is the impulsion forward, it becomes passionate: 'the triad of G yearns to move to the chord lying a fifth below it, C. Adding a seventh to C will make it yearn to move to F, and so on' (p91, my emphasis). In effect, the right sequence of chords is an adolescent driven by hormones. Taste is inevitably changed by this force. Newly attractive 'chains of chords' are discovered by Vivaldi and then dominate a period, or with Purcell, a country. So our hearing is affected and structured by learning the sequences, until they are finally consumed by fashion and then become predictable and finally boring. But they still relate to natural harmony, not far from the Pythagorean ratios that begin the story.

Conveniently for my argument, these 'laws' of harmonic progression, or The Circle of Fifths as it is usually known today, has a vivid architectural and chromatic structure. Such analogies, 'the harmony of the heavenly spheres' (and 'the music of the colour charts') are quite complex and worth exploring at greater length, by a musician, painter and scientist. Some believe, as Pythagoras thought in the sixth century BC, they extend into current cosmology, even Superstrings where some explanatory diagrams look like Mersenne's.

But here it is the simpler comparison that is at stake, the way composers and architects both use their 'magnetic force of forms' to create drama. If spatial progression is equivalent to the harmonic progression through chords, it leads to the idea that architecture might be in certain keys, or have a tonal centre, or underlying proportions. This idea certainly occurred to Le Corbusier (whose brother was a musician) and in well-known lines repeated throughout the 20th century he extols the virtues of harmonic proportions and 'architecture as the masterly,

correct and magnificent play of volumes in sunlight'. That is, a tonal architecture of pure forms in proportion to each other. In the chapter of Towards a New Architecture called, aptly, 'Architecture, Pure Creation of the Mind', he repeats the Pythagorean assumption that we are tuning-forks, and ones well-tempered to proportions that are beautiful. These ratios are the ones 'we feel to be harmonious (his emphasis) because they arouse, deep within us and beyond our sense, a resonance, a sort of sounding-board which begins to vibrate (187) the axis which lies in man, and so with the laws of the universe (196)'

In effect for him it is feeling not reason that is the judge of harmonious forms, as we experience the architectural promenade in space-time. One of Le Corbusier's most dramatic sequences is at the monastery of La Tourette which teeters on the side of a hill. Here the route takes us on both a classical and modern journey through formal tonalities and atonalities. Designed with Iannis Xenakis, the mathematician and 12-tone musician, it has pure forms seen in opposition, and visual chords that are both proportional and dissonant. On the upper side of the hill, the monks' cells over the entry create the simple and strong rhythms -- solid/void, A/B -- a classical rhythm that extends into the proportions of the parts, and this then holds the 'cornice line' around the site. But the descending volumes, and undercroft of the complex, take on entirely different character, a surprising curved, Gaudíesque tilt against the hill.

Xenakis, the atonal composer, was in charge of setting the rhythm of the lower windows, the 'ondulatoires', the glass and concrete verticals that buzz away tightly; then open up, like one of his serial compositions. These walkways are in brilliant counterpoint to the heavy cells above, with their remorseless dark beat.

But it is the culmination of the route which brings these themes to a climax. Here the buildings split apart, volumes move against each other in violent opposition, a concrete chimney smashes up to one side of a horizontal theme, a bridge jumps over the cornice, a blank wall stops the whole composition -- and zoom -- the eye leaps through the leftover void to the horizon beyond, a clear return to the cosmic view of architecture (and music).

In one sense, this architectural promenade summarises the debate between traditional tonal architecture and atonal Modernism, to the benefit of both. Xenakis, a risk-taking composer and good architect who built the Philips Pavilion for Le Corbusier, did not achieve popularity as a musician, the plight of other atonal Modernists such as Schoenberg and Webern. The reason often given is that, during an extended serial performance, very few have the concentration to perceive the underlying architecture. This may be true, but as La Tourette

demonstrates, it is not the lack of tonality per se that is the problem; or the dissonance, or any particular Modernist form or theme. Rather, I believe, it is the lack of local momentum, the way randomness destroys the all-important 'time-imperative'. During any performance there must be chaotic moments, and boring ones to relax the mind and allow forgetfulness. But their duration has a limit -- shorter than John Cage's four minutes and 33 seconds of silence -- before the listener gives up. Some expectations must be created, whether by rhythm, tonality, themes, melody, or anything (including gesture and silence) for the mind and body to anticipate the next moment, the near future.

In this sense, the epigram of Walter Pater is turned on its head: 'music constantly aspires to the condition of architecture'. The art of building has an easier time of showing its drama, because it can be inferred as a whole in a single glance. Viewers are more in control of perception than listeners at a concert, especially those hearing random, serial music who have no idea where they are going. The two arts may be equally abstract, equally modern and discordant; but the spatial ones allow a perceiver's participation and control in a way the time arts do not.

Consider a recent example of the iconic architecture now being built in Brazil, India, Russia, and on the Oil Route to China: Wolf Prix's latest essay in a cloud-like, singing metal. The grey forms are not much like anything seen before, except perhaps a whale. One can infer window-lighting where the gills and fins push out, and the pregnant bulge signals a huge public space, and maybe the theatre and opera house inside; and, unusual for a total abstraction, one can see where to enter: the front door is in front.

Like so many swooping constructions of Zaha Hadid and so much digital architecture in general, much of the surface is seamless and without cues as to up and down, base and top, gravity and flying. Thankfully, many fractal forms for lighting divide up the skin and give that scaling so necessary for architecture. The interior shows the same mixture of fractals and continuous curves, except now in different white harmonies. As visual music one can compare it to the swooping chords that Wagner used, and those of '70s composers such as Philip Glass and John Adams. There is tonality but it is always melding, there are rhythms but they are always morphing.

Unlike the other buildings here I cannot say if it works well, because I have not seen it. But that it works dramatically to sustain interest, as it continuously rises and falls and erupts, I have no doubt. It again proves the point that architecture can aspire to the condition of music because it too can be almost entirely abstract. But, when it gets rid of the usual distinctions

between ground, wall, window and roof -- as Blobmeisters have been attempting for 30 years; when it subtracts the usual cues of drama, then it reminds us of the time-imperative that cannot be escaped. It must reintroduce powerful new forces to set up new expectations. Otherwise, it will be too disorienting to hold our interest. Whatever else this 'whale' of a building does, as it cuts old anticipations it sets up strong new ones, and becomes a different type of music.

Pleasure of anticipation

The idea of such a time-imperative may be unexpected and alarming. But it is based on the truth that the body is as much a futurist as the mind. We project forward the next hour, minute and second to anticipate the flow of information, and that can be a matter of life or death. In sports it is well known that our body anticipates the pitch of a baseball, the slap of a hockey puck, the serve of a tennis ball much faster than we can think about it, and the reaction is often most skilful when most brainless (or on auto-pilot). It is often said that if you ask a centipede in which order it moves its hundred legs it freezes. Quick automatic anticipation of the next microsecond. is essential for walking and survival.

But of course the arts and sciences depend on thinking and feeling which have a much longer time-horizon, thousands of years, where expectations are built up in the complex web of interconnected culture. That is why it is impossible to fully appreciate either Gothic architecture or Relativity Theory, without knowing something about the codes and stereotypes that lie behind these cultural forms. And that idea is alarming for an age which believes everything is transparent, or can be quickly understood, or will become more so with all-glass architecture (the fantasy of the Expressionists and so much 'democratic architecture' today).

The implications of the time-imperative differ between the spatial-arts and time-arts, as I have mentioned, although all perception is in space-time. To reiterate, music is less perceiver-controlled than architecture because it cannot be inferred in a glance, and has to be experienced over a longer time frame before you guess how it will play out. Maybe, as with a conversation you are following, the inferences carry over about 20 seconds. The ability to follow a musical theme, or a verbal argument varies, but I remember when Information Theory and neural processing were first discussed together in the 1950s that general limits were set. The psychologist George A Miller published a famous paper called 'The Magic Number Seven, Plus or Minus Two'. This became a formula for thinking about thinking: that you could process seven plus or minus two bits (or chunks or objects) in your short-term, or working, memory. While no universal measure of this processing is accepted, the idea of

such limits is commonplace.

For listening to music this attention span of 'now' (that is, the flow of music as perceived and anticipated in the short-term memory) will vary as one becomes excited and then bored. Forgetting bits of a composition is necessary for being elated when they later come back, as one's auto-pilot perceives in its special thrill of recognition. The same is true in the architectural promenade, when one finally reaches the anticipated climax of seeing the Parthenon up close, and then is released into the cosmic view. But, whereas one can guess much of the whole promenade from the first view, the same is not true with the time-arts. These are more tyrannical -- only their author knows the plot beforehand -- and therefore music must continuously enforce new expectations, immediate goals, all the more strongly. I think Stravinsky's *Sacre du Printemps* proves the rule.

All perception has an element of goal-direction, as we project forward the next instant. Aristotle claimed that 'Man is a goal-seeking animal. His life only has meaning if he is reaching out and striving for goals.' This has its parallel in the arts which, as they unfold, generate their own goal. The time-imperative means that if our attention is not grabbed every now and then by both pattern recognition and the expectation of the new, we will not be engaged.

Putting together these thoughts, and the analogy between music and architecture, leads to further conclusions. The basic means in common between the two arts consist in rhythm, harmony, emotional intensity, meaning, the reliance on stereotype (or genre) and the progression of chords (or the comparison to an architectural journey through space). Many other details and figures are shared, such as chromaticism and glissandi, the use of overtones and morphing. Architectural and musical ornament can sometimes be more important than structure, and boredom and background are necessary for both arts.

But music is not for the most part background (except in shopping centres and muzak) and has no exact equivalent for the foreground flip of architecture into background urbanism. Music, as a time-art, is also much more controlling and authorial, and not meant to be experienced backwards or shift in speed with the perceiver. Countless more differences separate these two arts -- utility and cost -- but they are both routinely perceived as abstract arts, where form and content are one. This perception may be false from a semiotic viewpoint, because we know all communication is doubly-coded, but the experience of this illusion is no less convincing for that.

NOTES ON SOURCES

Rudolf Wittkower, *Architectural Principles in the Age of Humanism*, (1949, 1988) is still the standard look at the Renaissance use of Pythagorean harmonies in architecture.

I have also made much use of EH Gombrich, *The Sense of Order, A Study in the Psychology of Decorative Art* (1979) and its last chapter 'Some Musical Analogies'. It is as dense and rich as a late Beethoven Quartet and for architects interested in ornament repays reading with a pen in hand. Howard Goodall, *The Story of Music* (2013 and BBC programmes) is a most informative overview with as many provocative insights as one can find in a history of music.

Le Corbusier's view of the human as a superior tuning-fork is in *Towards a New Architecture*, 1927 (translated by Frederick Etchells), pp187, 196.

Geraint Franklin has provided some helpful comments, and I have been helped in the diagrams here by Megan Burke. Some of these historical sources can be found on Google Images.

1. Notre Dame nave, the canonic view experienced as a whole. Its spatial proportions of width to height -- $1/2.7$ -- enhance its spiritual meaning. Music is experienced over time, whereas architecture is grasped as a spatial whole

- 2. The Pythagorean Monochord (top) like a cello tuned by God, revealed the cosmic connection between harmonic sound, whole numbers, perfect proportions, geometry and then architecture designed on the same ratios. The human body (middle) also disclosed these proportions and thus the plans of cathedrals -- certain lengths -- were ordered to these ratios: the 'perfect octave', (diapason), 'perfect fifth' (diapente) and so on. This system of harmony was worked through for three voices during the Gothic period (lower left), and the system was itself 'perfected' in the Baroque period (lower right). With God still fine-tuning and (centre of drawing) the sun, moon, 'fire, air, water and earth' presiding over the cosmos, architecture was inevitably designed to reflect this music
- 3. Temple of Concord, Agrigento, Sicily, 450 BC. This view shows the Pycnostyle in front, and a screen of flutings on the side, because of viewpoint an even faster beat. Pythagorean proportions of column to intercolumniation, front to side, and width to height (roughly 2:1 here) also determine many other relationships of the Greek temple
- 4. Peter Eisenman, Memorial to the Murdered Jews of Europe, Berlin, 1998-2005, another contrast of violent, staccato elements
- 5. Notre Dame inferior, bay rhythm and its three superimposed levels. Each of these horizontal areas can be seen as a different choral voice. At the time, 1240, the composer

Pérotin was superimposing one plainsong chant on top of another: musical and architectural harmony developed in parallel through notation systems. The notebooks of Villard de Honnecourt, circa 1240, show the nave elevation of Reims cathedral, and reveal that he appreciated its rhythmical subtleties

- 6. Evolutionary series of the High Gothic over 60 years. The horizontal emphases are in green, the vertical in red, the oppositions are pushed to greater and greater pitch, as the dialectic of visual forces dissolves the wall. For instance, note the central colonnette of the Amiens triforium that is thicker, like the one Villard drew at Reims to show the vertical emphasis
- 7,8. Daniel Libeskind, Jewish Museum, Berlin, 1989-2001, using the natural expression of dissonant angles, descending lines, discordant cuts and slashes, and structures breaking through each other
- 9,10. Sauerbruch Hutton, Brandhorst Museum, Munich, 2008-11. The stripes of colour are tilted in horizontal layers to deflect the road noise from the museum and muffle it, a clever invention that won the competition for the architects and, as a by-product, created the haunting set of joyful illusions that change with the distance of the observer. The sliding and shifting between visual chords here produces a literal version of musical chromaticism, the blending of colour overtones
- 11,12,13. Wolf Prix, Coop Himmelb(l)au, BMW World, Munich, 2003-10. The flat roof and a simplified palette provide the major chords that hold together the swooping glissando and trumpet blast at the entrance corner. Shapes, geometries and materials morph together like the continuous slide of an electronic guitar: do these 'energy progressions' of Prix amount to 'chord progressions'?
- 14. Alan Short's School of Slavonic and East European Studies, London, 2004-6. The background brick architecture of London was mandated, but this contextual architecture was given subtle articulation for ecological and semantic reasons -- to create new rhythm of exhaust stacks and double-walled insulation, and to relate to the Slavonic traditions
- 15,16. Herzog & de Meuron's CaixaForum, Madrid, 2003-08. Preserved brick facade sets the A/b bay rhythms which are taken up as harmonic chords in the top rusted iron addition and set against the vertical garden and void at the base. Reading horizontally gives some basic melodic lines, while reading vertically reveals both harmony and dissonance. But the large contrasting blocks of colour and material are like the strong Stravinsky chords, the violent instrumentation of The Rite of Spring
- 17,18. Edouard Francois, Hotel Fouquet, Paris, 2004-6. Most visible is rhythmic syncopation between the mandated repro-style and the modern picture windows. Five melodic voices are in Contextual Counterpoint, like the CaixaForum. This architectural genre starts with the work of Venturi and Stirling in the 1970s, but here in Paris it reaches greater subtlety. Note the shades of grey, black and silver; they add harmonic overtones to what might have been the boredom of prefab repetition
- 19. Frank Gehry, Disney Concert Hall, Los Angeles, 1988-2003. With rhythmical ranks of reflective forms in Douglas Fir surrounding the 'vineyards of people', this space is a frozen image of acoustic curves billowing and rippling out from the orchestra
- 20. Diagrams showing the Circle of Fifths, taken from The Architecture and Colour of Music. The major 12 keys start with C at the top (and progress or regress five piano keys),

while the minor scale is on the inner circle, and some harmonic overtones apparent in the ratios. The Mersenne Star (top) was drawn in 1648, but the more regular harmonic relationships were only fine-tuned geometrically (or 'tempered') by JS Bach later, in the early 1700s. Note the mixing of colours, a chromatic scale, yet another metaphor like the geometric one

- 21,22. Le Corbusier, La Tourette, France, 1953-61. Pure volumes in proportion to each other and dissonant; regular harmonies and rhythms set against atonal and serial window verticals designed by Xenakis; Classical squares, cubes, pyramids juxtaposed with discordant slashes and diagonals
- 23,24. Coop Himmelb(l)au, Dalian Conference Centre, China, 2008-12. A continuously changing surface that rises and falls and bulges in the middle to include a theatre and opera house. Organised like block chords of music that open up and close, it is reminiscent of both Wagnerian chromaticism and the tonal melding of Philip Glass and John Adams
- 25. At the heart of the Dalian Conference Centre is a traditional horseshoe shaped auditorium with a capacity of 1,600 seats. The classic auditorium is reinterpreted for the modern era, with riotous decor and acoustically pimped surfaces. Here there is tonality, but it is always melding there are rhythms, but they are always morphing

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By CHARLES JENCKS

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