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"Collected Writings of the Orpheus Institute"
edited by Peter Dejans

CAHIER «M»

A Brief Morphology of Electric Sound

Dick Raaijmakers

COLLECTED WRITINGS OF THE
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PREFACE

CAHIER-M by Dick Raaijmakers is the third volume of the *Publications by the Orpheus Institute* series.

Like the preceding publications, *Inter Disciplinas Ars* and *Theory into Practice*, this third volume is the result of conferences held at the annual Orpheus Institute seminar at Château de la Rocq in Arquennes (Belgium), in November 1999. Dick Raaijmakers was one of the guest speakers and gave a tremendously fascinating and enthralling series of lectures about the musical experiences he had gathered during his artistic career. At Orpheus Institute's request, he elaborated on this subject so as to turn it into a book.

The fact that Dick Raaijmakers should be a special case in contemporary music already shows that his music has never been performed by orchestras or ensembles. This absence, however, is inversely proportional with the respect he commands as an experimental composer, thinker, and professor. This is certainly not to say that he is 'misunderstood', let alone 'marginal'. The preconditions for performing his music, however, are such that they simply will not fit in the almost institutionalised canvas of the modern-day music production apparatus. This is aptly illustrated by his *Elektries Strijkkwartet* (Electric String Quartet), whose title he changed to *Kwartet Heiliger Dankgesang* under the influence of the seminar at Orpheus Institute and the technological rewriting.

Like no other, and throughout his countless works, Dick Raaijmakers has consistently managed to pinpoint what is really the issue. To him, art as a problem to be solved, an exposé, is the only approach for turning art into a dis-closure. It is this analytical, revealing aspect in Raaijmakers' work that turns him into one of the main musical creators of the 20th century. Judging by what he has to say in this publication, he proves to be an equally brilliant thinker and ex-pounder.

The original Dutch version of CAHIER-M, is available under ISBN 90 5867 075 9.

I would like to seize the opportunity to thank Dr. Godfried Willem Raes for his contribution to this book, co-editor Frank Agsteribbe and all who made this publication possible in the first place.

Peter Dejans

INTRODUCTION

The letter 'M' in CAHIER-M stands for morphology, 'mouvement', Marey, Mondriaan, and, of course, music. CAHIER-M is first and foremost about the morphology of artificial, electrified sound. This investigation will not be restricted to aural sound, however; it will also delve into the morphological appearance of mechanised and electronified images. Sounds and images will not be discussed separately, but together based on their mutual relationship. CAHIER-M is structured in such a way as to provide the reader with a varied, sometimes surprising, view on this morphological analysis.

More specifically, CAHIER-M deals with the horizontal structure of picture sequences as stored on moving, string-shaped picture media (tape, film), which has been around for quite some time, and compares it with the vertical layer structure of stacked images on non-moving 'picture plates' ('plaques fixes' and hard disks). While the 'horizontal' representation method of so-called electronified visual and aural images has become commonplace, the 'vertical approach' is still under construction, so to speak. The combination of these two approaches, horizontal extension and vertical layers, produces images of a holographic rather than tomographic nature. Neither the images nor their carriers move, while the respective users of these images do. Interaction with these images is therefore the only way to establish a relationship with them.

CAHIER-M wants to engage in a morphologic discussion of a number of combinations of these horizontal and vertical ways of structuring pictures. In order to fully understand what this is all about, I shall also try to define the concept of electronic sound by differentiating between typically single-layered horizontalised, hence instrumental, sound generation of pre-WWII electronic musical instruments on the one hand, and multi-layered verticalised, complex textures advocated by serial composers after WWII.

CAHIER-M comprises four chapters that are called 'invented sound', 'diagonal sound', 'composed sound' and 'spatial sound'.

In chapter 1, I shall deal with 'invented' electronic sounds by contrasting it with its rather more structured, 'composed' version. Both types of sound will also be analysed with respect to the ideas voiced by the painter Piet Mondriaan, who, in the 1920's, developed and advocated 'neo-plastic music'. Even though Mondriaan had to base his ideas on an instrumental, albeit purely electric, framework, they were clearly conceived by a creative artist. His instrumental and compositional ideas lead to a surprising mix.

In chapter 2, I shall deal with the principle of diagonal sound. Again, Mondriaan will take centre-stage, but this time as philosopher dealing with graphic concepts. His ideas about a flat reception of neo-plastic pictures and buildings will be applied to the perception of flat, neo-plastic music. In this chapter, the plastic shape of this strongly idealised flat music will be expanded into a system of aggregates consisting of layered sound levels. These aggregates can be perceived both head-on (*en face*) and form the side (*en profil*). (I shall also ask the interesting question how sound is usually perceived: from the side or head-on.)

Chapter 3 is about composed sound and consists of two parts. The first is devoted to a discussion of the various manifestations of artificial images, where I shall concentrate on their social and hierarchical dimension rather than their technicalities. Part two deals with the so-called 'horizontal arpeggio' of the French composer Pierre Boulez, which I shall call a derivative of the morphologic appearance of the aforesaid sonic aggregates. Via the introduction of the terms 'horizontal' and 'arpeggio', Boulez, in his work *Répons* written in 1980, puts the principle of the spatial distribution of layered sound (the verticalised sound aggregate) into practice. By doing so, Boulez thus adopts a layer method similar to the one concocted by the French physiologist and film pioneer Etienne-Jules Marey around 1890, thus producing a historic and methodological repetition of a concept developed almost one hundred years earlier. While Marey's efforts centred on graphic and photo-

graphic efforts for capturing movements by means of carriers that do not move by themselves (so-called 'plaques-fixes'), Boulez derived his method from the desire to bestow sound with an organised, spatial character in real-time.

In chapter 4, which is about spatial sound, I shall analyse to what extent Marey's picture arpeggios could be considered early predecessors of modern-day 'liquid' trans-architectural shaping methods, inasmuch as they can be created by means of graphic information produced by a computer. To this end, I shall cite a few telling examples ranging from *Le Poème Électronique* by Iannis Xenakis (1950's) to forms of hybrid constructions that are increasingly 'en vogue' in contemporary architecture.

The correspondences I shall claim in this chapter will be explained and discussed by means of the superposition method I used in the 1960's both in a methodological and deductive way and largely abstract electronic sounds. This morphological method was not only devised twenty years before Boulez' composition of horizontal arpeggios, but also proves to be akin to both Marey's pictures and the 'liquid forms' of the aforesaid architectural currents. Using this approach as a model will allow me to discuss and present the subjects of CAHIER-M.

1.
INVENTED SOUND

1.1 TECHNICAL EXPANSION

The evolution of technology during the last century did not run in parallel with the evolution of music. Far from it: the evolution of music and technology seem to be diametrically opposed. Though the twain sometimes meet, we can hardly call this a fusion. The idea that technology should be the result of a well-defined, intense, musical desire, and therefore at the service of music, is utterly wrong. Technology follows its own pattern and usually could not care less about music, or art for that matter. There may be times when musicians become aware of an unexpected technological 'offer' that opens their eyes and is perceived as the response to a latent thirst for innovation. (It has to be said that the composer or instrumentalist must be 'prepared' for such an experience in much the same way as prospective saints must be 'prepared' to accept mercy.)

1.2 WISHFUL THINKING

Whenever receptive musicians are faced with a new technological tool, they are reminded of their hazy dreams in that the tools seem to meet their illusory expectations and what these open-minded musicians want to hear.

The mechanism that is then triggered can be illustrated with Ferruccio Busoni's utopian essay: *Entwurf einer neuen Aesthetik der Tonkunst* (1907) where a dream seems to come true simply on the basis of a vague piece of information about a new, electromechanic musical instrument invented by a certain Thaddeus Cahill in New York: the 'dynamophone'. Busoni's optimistic expectation is completely unaware of how the instrument must have sounded, so that nothing can keep him from responding to this stimulus by inflating his vision beyond proportion.

The thirst for new technological tools is usually based on scarce, sometimes insignificant and obscure supply; a supply where the engineers are usually unaware of the fact that they indeed have something to offer for the arts. Especially between WWI and

WWII, technology regularly stimulated musicians, instrument manufacturers, and composers, sometimes without knowing or intending it. It just happened to music; technology may have caused expectation shocks, but nobody — not even the musicians themselves – knew exactly what the arts were expecting from technology.

It is fair to say, though, that technological supply was a little ahead of its time, because music wasn't ready for it. A technological tool cannot influence the evolution of music if musicians and composers are not ready or willing to use those new tools. Any attempt to influence evolution without the right breeding ground is doomed to fail. The music scene therefore responded in a telling, even Freudian, way: it did not work, the new tools were never adopted. The supply proved a hoax (that is what we call it today, even though it certainly wasn't perceived as such in those days).

1.3 COMPOSITIONAL SUPPLY

After WWII, the mood changed dramatically, thanks to technical tools that proved useful to the music scene for composing rather than performing music. They allowed composers to use a number of electronic devices for creating temporal and sonic textures that could be committed or stored to audiotape, data tape, punched cards, and later in digital computer memories. This led to the appearance of a new kind of operator with an entirely new function and position: the composer of electronic music as a shaper of sound who no longer had to rely on musicians for performing the music! Such operators did not exist before WWII. Those daring enough to implement technology in music were musicians or instrument manufacturers: real *inventors* who built their own, usually electric, musical instruments. Those instruments have come to be called 'electrophones'. The difference between the people who invented electric musical instruments during the pre-WWII period and composers of a more autonomous, mainly electronic kind of music after WWII lies at the heart of the pace at which music evolved with respect to technology in those periods.

1.4 THE INVENTOR

An inventor is by nature future-oriented. This frame of mind allows him to fire original concepts at the world, which he then tries to introduce to other areas as well, being a creator by profession. Call it giving his or her invention a new life, if you will, because this attempt is about the desire to create new, unheard-of, variants that — in our case — affect the evolution of music, even though the music scene itself has never voiced the desire for such a tool. It therefore goes without saying that the inventor believes to be the best man or woman for the job of bringing such musical instruments to life and promote their use.

The inventor usually looks for patterns hitherto unknown to society but which he believes to be worthwhile. More specifically, he wants to devise literally unheard-of electric tone generators with huge potential for creating sounds, performances, techniques and notation. He literally projects images of future instruments onto the retina of our senses; instruments that used to be relegated to a distant past but have now been 'discovered' by them for the benefit of mankind and the music scene. He wants to promote his or her inventions as examples to be used by us who, until now, were stuck with conventional instruments. At first sight, this looks like an unselfish attitude, yet the fanaticism with which the inventor tries to impose his ideas onto a world that doesn't seem to understand, turns it into a rather dangerous endeavour.

Despite our scepticism, the inventor is convinced that his invention will end up making a lasting impression on society, culture and music. This may take some time, because when they are first introduced, such new instruments produce rather primitive sounds to a point that nobody really wants to listen to them. That, of course, is what *we* think, not the inventor, blind and deaf as he is to the inherent initial shortcomings of his invention.

1.5 INVENTION VERSUS EVOLUTION

An inventor usually believes that his instruments are finalised and perfect instruments. Little does he know that musical instruments one invents ad hoc are doomed to fail unless they are the continuation of already available families.

The violin, for one, like the human voice, was not built in one day. Far from it: it was thanks to generations of violin manufacturers who saw the instrument's potential as a main variant of the large family of stringed instruments, that the violin came to be seen in isolation from its family and therefore enjoyed a significant evolution. Contrast that with another string instrument, the 'barytone', for which Haydn wrote about two hundred compositions, but which has nevertheless only survived in a dark corner of a musical instrument museum.

This is exactly what happened to the epitome of an invention that proved worthwhile, the 'saxophone'. Even that instrument did not simply come out of the blue: it was the result of Adolph Sax's attempts to proceed by cross-fertilising the fingered instruments known to him, such as bugles, clarinets, and the 'ophicléide'; he did so in a careful way so as to present a 'finished' instrument. (In much the same way as others try to develop a kind of tulip that presents several characteristics of a rose or hyacinth; and even there it remains to be seen whether such a tulip can survive). Yet, such attention to detail and scepticism is usually absent from the mind of the inventor of musical instruments: he is convinced of the importance of the new instrument, witness the way in which such instruments are usually presented to the outside world and the heavy lobbying.

1.6 INVENTED TONE

What are the inventor's expectations based on? He indeed has no direct impetus to start inventing something, only suggestive feelings that such an invention is needed. The most important drive no doubt remains his fascination for the typical nature and the phenomenological quality of electric tone. He wants to instrumentalise and shape this intangible tone and give it a palpable, instrumental 'haven'. Here's how he goes about it:

Electric circuits, such as tone generators, produce non-mechanic, bodiless frequencies that become audible as tones only via speakers. Such tones by definition have a rather thin sound, are indefatigable and, in fact, timeless (in much the same way as ectoplastic manifestations of forgotten, occult, mysterious media, are thin and timeless). The tones 'come out of' circuits, connections,

and apparatuses that do not move themselves but remain in a kind of timeless 'trance' if you will; still and nevertheless in motion, such tones completely live up their immaterial and 'secretive' status. Consequently, electric generators cannot really be called 'bodies' of the resonating kind in musical instruments. They are 'value clusters' that cannot not be experienced through their actions but rather through the result of these actions. The fact that this should possible thanks to electricity shrouds such instruments in profound mystery.

1.7 SETTING

An electric generator usually wants to produce a single sound forever. As far as the generator is concerned, the initiative to change this status must come from outside. If such a stimulus fails to be received, the tone continues, unchanged. 'Outside' refers to something or someone who changes the 'settings' of the electric parts inside the generator. Changing a setting is an instrumental intention.

Changes to the tone are usually possible by setting three knobs that protrude from the tone generator. You can operate those knobs: two of them continuously, and the third in pre-defined steps. One of the two continuous knobs affects the frequency and thus the pitch, while the other allows you to control the amplitude and thus the volume. The third knob specifies the frequency pattern and thus the timbre, or tone colour. If there are only four frequency patterns — sine, square wave, triangular wave, and saw wave — there are only four steps. All other frequency patterns will be derived from or based on a combination of these four.

1.8 THIN AND FINE

It is in the inventor's best interest to present the new electric sound in such an immaterial and uninstrumental way that it seems otherworldly. The thin character of this tone suggests both the utopian vision of the future and the forgotten and lost past. Whenever the electric tone is used for psychic or therapeutic reasons, its purity and 'cleanness' will no doubt have a healing effect on our soul and body. Furthermore, such sounds appear well suited for educational purposes, especially for ear-training

exercises, thanks to the possibility to quartertone, sixth-tone, eighth-tone, or even finer scales. This causes the inventor to expect the world from his device, without ever worrying about first getting acquainted with these aspects. (The inventor does not see such lack of experience as a handicap: it seems to be a prerequisite for living his utopian feeling to the full.)

1.9 FROM PERFORMER TO COMPOSER

As a consequence of an exaggerated idealisation of his new contraption, electric sound, the inventor starts concentrating on the concrete rather than the abstract nature of this sound, and therefore shifts his focus from language to speech. This shift is mainly regressive in nature. From the point of view of evolution, language is more important than speech: the first encompasses the second, not the other way around.

In this respect, a composer who decides to work with sound is confronted with the same hierarchical shift. In order to arrive at sound, he must forsake his status of 'language artist' and retreat to the level of 'sound organiser'. While a composer dreams of a music with new timbres, he leaves the level of articulate and composable sound — language — to descend, in a regressive fashion, to the level of suggestive, associative, tactile sound — speech. Such a composer, who works with sound, uses three variables — or sound parameters: pitch, volume, and timbre, the same variables that can be manipulated by means of the aforesaid three knobs on a tone generator. The action of determining sound parameters by means of entering numbers quickly gives the composer the idea that the possibilities of his or her new tool are endless. (That's exactly why he is a composer, someone who, by profession, knows how to organise and select among infinities.)

The inventor, on the other hand, faces a different challenge. Whenever the ostensible presence of a certain infinity starts causing problems, he considers this 'wealth of endless possibilities' an as yet unintelligible message. It is therefore his to pass it on to mankind for its own benefit — and his own, of course. In order to present this message, the inventor promotes his status of instrumentalist to that of a composer. This allows him to present the unimaginable and impalpable dimension of electric sound as

something imaginable and palpable. In other words: the inventor gets promoted, and never fails to inform the world about his new status!

1.10 CENTAUR

The inventor is in fact a kind of modern centaur: half engineer, half musician, and therefore a typical hybrid figure. Never a full-time composer, nor a good performer or consistent scientist. Just a dreamer of unheard sounds, meaningful digits, new kinds of music, and — more importantly — of its wholesome effect on the body and soul.

It comes as no surprise that the inventor is usually the only person to perform on his or her instrument because he believes to be the best instructor for showing others how to use his instrument (never mind 'initiating' others to his invention).

Another constant seems to be that the inventor loves to call his invention after his own name: Jean Martenot's 'ondes martenot', Friedrich Trautwein's 'trautonium', Lev Thermen's 'theremin', and Bruno Helberger's 'hellertion' are just a few examples that spring to mind. Such names are used to hint at a tradition that is simply not there.

In order to promote his instrument and the message it contains, the inventor tries to talk famous composers into writing music for his invention that features the instrument's specific qualities and characteristics in the best way possible. And while he is at it, the inventor also concocts a new tone and notation system suitable for the new instrument, because he believes, of course, that the traditional twelve-tone system is far too coarse to match the 'fineness' of his invention.

1.11 FUTUROLOGY

If we summarise the above, it becomes clear that the inventor, and even more so the species before WWII, has several functions out of sheer necessity. Not only is he an inventor, he is also a physicist, musician, performer, theoretician, notation expert, demonstrator and, of course futurologist. Based on three quotations from composer and theoretician Ferruccio Busoni and two typical representatives of this kind of inventor, Jörg Mager and Friedrich

Trautwein, it will be shown how those inventors tried to put their futurologist ideas in words.

1. THADDEUS CAHILL developed his 'telharmonium' (or 'dynamophone') in New York around 1906. In his essay, *Entwurf einer neuen Aesthetik der Tonkunst* (1907), Ferruccio Busoni reacted to a newspaper article about this instrument (with the telling title *New Music for an old World*) in ecstatic terms and ideas, even though he had never heard the instrument.
"... Wichtig und drohend ist die Frage, wie und worauf diese Töne zu erzeugen sind. Es trifft sich glücklich, das ich während der Arbeit an diesem Aufsatz eine direkte und authentische Nachricht aus Amerika erhalte, welche die Frage in einfacher Weise löst. Es ist die Mitteilung von Dr. Thaddeus Cahills Erfindung ..."
(Description of the apparatus.)
"... Nur ein gewissenhaftes und langes Experimentieren, eine fortgesetzte Erziehung des Ohres, werden dieses ungewohnte Material einer heranwachsenden Generation und der Kunst gefügig machen. Welche schöne Hoffnungen und traumhafte Vorstellungen erwachen fur sie! Wer hat nicht schon im Traume 'geschwebt'? Und fest geglaubt, dass er den Traum erlebe? Nehmen wir es uns doch vor, die Musik ihrem Urwesen zurückzuführen; befreien wir sie von architektonischen, akustischen und ästhetischen Dogmen; lassen wir sie reine Erfindung en Empfindung sein, in Harmonien, in Formen und Klangfarben ...; lassen wir sie der Linie des Regenbogens folgen und mit den Wolken um die Wette Sonnenstrahlen brechen; sie sei nichts anderes als die Natur in der menschlichen Seele abgespiegelt und von ihr wieder zurückgestrahlt; ist sie doch tönende Luft und über die Luft hinausreichend; im Menschen selbst ebenso universell und vollständig wie im Weltenraum; denn sie kann sich zusammenballen und auseinanderfliessen, ohne an Intensität nachzulassen ..."

2. In 1923, JÖRG MAGER (also known as "Begründer der Deutschen Elektromusik-Forschung") and Jens Warny demonstrated the 'sphaerophon', and in 1931 the 'partiturophon'. In an article, Mager speculated about the significance and potential of the new, matter-free, spherical, mystic, pure and — thanks to electricity — 'immaterial' tones.
"... Mit den technischen Mitteln des Rundfunks ist ein viel Höheres, Gewaltigeres zustande zu bringen [... than the function of merely reproductive instrument for consumption purposes ...], nämlich der Tonkunst die Gesamtheit aller Schwingen, sowohl für Melodik als auch Harmonik, ja sogar für alle Partialtöne, von denen die Klangfarbe abhängig ist, zur Verfügung zu stellen. Mit dieser Totalität kann uns ein Ton-Neuland erstehen, das alles bisher Erreichte vollständig in den Schatten stellt ..."

3. FRIEDRICH TRAUTWEIN, finally, built his first 'trautonium' in Berlin, between 1928 and 1930, and then made the following statement. Please pay attention to the two instances where he emphasises the creative part of music production, rather than the instrumental, reproductive and mechanic aspects. He is first and foremost interested in the composer, not the instrumentalist, the creative rather than the re-creative aspect. Unfortunately, his instrument to not live up to his expectations ...
"... Ich will für den schaffenden Künstler neue Ausdrucksmöglichkeiten bereitstellen. Die mechanische Musik hat die Kunst als solche nicht bereichert, sondern in erster Linie verbreitert. Ich aber glaube, durch meine Arbeiten vor allem der schöpferischen Kunst zu dienen und damit zur Versöhnung der beiden fälschlich in Gegensatz gedrängten Zweige menschlichen Geistes: Kunst und Technik, beizutragen ..."

1.12 MONDRIAAN'S NEO-PLASTICISM VERSUS NEO-BECHSTEIN

An even more striking and telling example is that of the painter Piet Mondriaan (1872–1944) who, based from his ideas about so-called neo-plasticism, started to build a connection with music on the one hand. We shall also analyse to what the Neo-Bechstein — an electromagnetic grand piano — was capable of meeting these expectations.

"Et quant au moyen de production du son, il sera préférable d'employer l'électricité, le magnétisme, la mécanique, car ils excluent mieux l'immixtion de l'individuel." This is what Piet Mondriaan said in his essay Le Néo-Plasticisme (De Nieuwe Beelding) which was published as a brochure in late 1920 by the L'Effort Moderne in Paris. This essay was dedicated to the 'hommes futurs' — future mankind. In this essay, Mondriaan, based on an analogy with a new plastic art (painting), tries to definie a new kind of music the sounds of which should ideally be produced by electric, magnetic, and mechanic (i.e. automatic) devices to avoid undesirable alterations based on individual, subjective and interpretational preference.

1.13 PULSE TONES

Mondriaan advocates a kind of music bereft of any kind of personal feelings, depth, warmth, and empathy and whose sound no longer presents the 'roundness', 'swells', 'reverberation', or other

typically instrumental characteristics of a romantic idiom. The sounds should rely on a few basic tones and not be structured harmonically but rather as unbreakable units. They should be experienced as 'coups' — pulses. No melody, but quick sequences of primary tones and so-called non-tones. Mondriaan imagines tone fields that are enclosed by three tones: a 'red' one, a 'yellow' one, and a 'blue' one. Based on a concept of confrontation, these fields are counterbalanced by non-tonal fields whose corners are based on a-chromatic, atonal, noises, 'black', 'grey', and 'white'. These six tones have an immediate attack and no release. Together, they constitute compositions of contrasting 'coups' (hits) whose rhythm is open and free.

Mondriaan believes that these tones or sounds need to be generated by electric devices or newly developed musical instruments; it is of prime importance, however, that they be 'fixed' unequivocally in a yet unknown way. In his text about Néo-Plasticisme, he therefore talks about soulless things, such as 'l'électricité' and 'magnétisme' of which he later (in late 1921) said that they were ideally suited for generating tones whose 'wavelength and oscillation' remain constant for their entire duration. He also demands that those new musical instruments, whether or not they are fitted with 'électricité' and 'magnétisme', be capable of instantly switching off a tone, without 'reverberating noises' or the like. These are precisely the criteria that can be met a lot better by electric sounds than instrumental sounds. Electric tones indeed have no body, they do not linger on, and they go off in the same way as when you switch off a light bulb. They never tire and are by definition tight and stationary.

1.14 PROTO-ELECTRONIC MUSIC

It strikes one as remarkable that Mondriaan talked about a kind of music in 1920 that emerged thirty years later under the name of 'Elektronische Musik' and whose realisation and sound characteristics corresponded exactly to what Mondriaan had in mind: a real neo-music that, from 1952, was mainly and most consistently developed by Karlheinz Stockhausen. There, too, a lingo of Mondrianic proportions was used, with concepts such as 'dead tones' (Karel Goeyvaerts), 'reine Sinustöne' (Herbert Eimert) and their

compounds to be used as so-called 'Tongemische' (Stockhausen). And, as Mondriaan had suggested, Stockhausen differentiates between 'Klänge' and 'Geräusch-Klänge' (Mondriaan called them tones and non-tones), and combines these tones, non-tones, sounds, and non-sounds into specially devised compositions (studies) where they alternate with one another at *high speeds* (sic!) *in horizontal and vertical directions* (sic!). The purpose of this approach is to stay clear of associations with quasi-rhythmic, motif-based, melodic, and harmonic movements of a more traditional kind as much as possible.

This electronic music was created by the composers themselves in closed studios (ateliers) without interference of subjective interpreters or performers, and — of course — without traditional musical instruments. They used specific elementary apparatuses, such as the sine wave generator. Moreover, these electric sounds, true to Mondriaan's spirit, were directly committed to magnetic tape — a technique the consequences of which Mondriaan cannot possibly have foreseen to their full extent but whose essence he was able to imagine. In short: Mondriaan's dream came true to an incredible extent, even though the following following should be noted.

1.15 COMPOSED SOUND

Biased by the situation in 1920/21, Mondriaan, while advocating new music based on neo-plasticism, thought first and foremost of developing an entirely new array of musical instruments. Had he gone but one step further, he would have arrived at the conclusion that true music should not be left in the hands of instrumentalists, not even the ones of Luigi Russolo and his futuristic 'Intonarumori', whom Mondriaan admired; it should have been left in the hands of his colleagues, the composers. "... Let's get rid of all instruments — even the electric ones! ...", or "... Let's get rid of all instrumentalists and their concoctions! ...", is what Mondriaan should have said. Indeed, only composers are capable of producing the desired kind of music in a 'direct', 'non-subjective' and 'unindividual' way — not the 'subjective' and 'individual' instrumentalists. This position is closely linked to the following.

1.16 THE NEO-BECHSTEIN

The year 1931 saw the introduction of a completely new kind of musical instrument: the Neo-Bechstein. At first sight, it looked like a traditional grand piano, whose principle of mechanic sound generation (with strings, hammers and sound board) were, however, complemented and partially replaced with the principle of 'l'électricité' and 'le magnétisme'. This instrument was developed by Prof. Dr. W. Ernst in collaboration with the piano manufacturer Bechstein and the electronics firm Siemens-Halske. It is interesting to wonder to what extent the Neo-Bechstein met the criteria for true neo-plastic music, voiced by Mondriaan ten years earlier. Especially since Mondriaan's statement about 'electric' and 'magnetic' elements could very well have been used by Bechstein in their brochures, except that this would have meant the collision of two totally different worlds. (Unless one has already apprehensions at what Mondriaan used to call the exclusion of "l'immixtion de l'individuel", the meddling of the individual. There can be no doubt that the manufacturer of the Neo-Bechstein was aware of the importance of stating and demonstrating that musicians performing on this new electric musical instrument could indeed 'add' their personality to the music they were playing. That is precisely where Bechstein's interest lies: it may be 'neo' because of the electric aspect, but it is nevertheless a real musical instrument!)

1.17 NEO VERSUS NEO

Given that Mondriaan, with his ideas about non-subjective, unindividual music, clearly gives an idealised picture of what he had in mind, it is safe to say that he would have rejected the Neo-Bechstein as a first step towards neo-plastic music, because of the unavoidable 'roundness', 'swells' and 'reverberations' of the Neo-Bechstein's piano tone. Despite the electric and magnetic principles, this instrument simply could not have been accepted by Mondriaan if this interpretation of his intentions is correct. Bechstein's 'Neo' indeed has nothing in common with the 'Neo' in Mondriaan's plasticism. Furthermore, Bechstein's 'Neo' — call it a 'beta principle' if you will — is in no way connected to the typical

alpha principle of Mondriaan's artistic, plastic, and musical ideas. Now there's a reason for not putting into practice the ideals of new neo-plastic music, one might say.

To get a better grasp of the Neo-Bechstein's 'Neo-ness', consider the following. There are two possibilities for linking two distinct techniques — here an electric and an instrumental one: the two techniques are indeed connected to each other and merge as equals, thus producing a new kind of technique, or they don't. It's one or the other. When it comes to fusion, techniques follow the same pattern as living organisms or inorganic substances in chemistry. If one implants an organ into a living organism that does not match the receiver's requirements, the body will reject that organ. Much the same is true of the attempt to mix inorganic substances in chemistry. By putting two or several substances in contact with one another, you either get one new element, or a compound of basic substances that you can tell apart quite easily. If you install a foreign electronic device into a system comprising a sound board, strings, and hammers of a grand piano, which does not work together with the receiver, the grand piano will reject the electronic part, or the implanted item dies. This could be called a matchmaker's, short-lived wedding of two persons who are forced to live together, but never become a tight union capable of evolution and reproduction.

1.18 NEO VERSUS TRADITION

The manufacturer of the Neo-Bechstein was quick to realise this and therefore decided to camouflage the impossible superposition of a piano and an electronic device by hiding the inner works to the eye (and the ear!) and — this is significant — by means of a traditional grand piano lid. But that did not do away with that other 'impossible' superposition, epitomised by the words 'Neo' and 'Bechstein' imprinted on the front of this grand piano. We can but conclude that the idealised integration of strings, wires, coils and magnets was so important to the manufacturer that he thought that the underlying importance needed to be emphasised by the name 'Neo-Bechstein'. More importantly, he tried to set it apart by means of gold-plated magnets, even though the gold later proved to be sham.

1.19 THE PIANOLA

The 'pianola' is the perfect example of how a forced 'cohabitation' of a foreign technique in the home of another technique can survive longer than expected: a piano that can play without a pianist. Even though this was an ad-hoc combination of a traditional piano, with strings, hammers, keys and all, and an automatic playback device with compressed air, levers, rolls and built-in programmes, these two worlds are functionally akin to each other. Both are indeed about 'hammering'. Whether that hammering is brought about by a keyboard or a piano roll is irrelevant. (From a technical point of view, mind you, not from a musician's point of view.)

The pianola, as an automatic music performer, clearly met a demand because, having been invented before that other, totally automatic device, the gramophone, it became tremendously popular. Only after the gramophone's breakthrough, after WWI, did it become clear that the pianola's genetic potential (so to speak) proved too weak to coexist with its competitor. The pianola has therefore all but vanished from the surface of the earth, while traditional upright and grand pianos have been manufactured to this very day and will still be around in the foreseeable future.

1.20 IMPOSSIBLE

The Neo-Bechstein's existence, even compared to that of the pianola and other related automatic piano machines, proved short-lived. It went out of production after only several hundred units. The electric coexistence of this grand piano literally proved impossible and 'far out'. After all, what should one think of an instrument forced to share its cabinet with 'l'électricité' — complete with wires, pots, magnets, valves, amplifiers, and what not —, and with a complete radio receiver? A surreal gathering that competes with that other coexistence of the 1930's, the umbrella and sewing machine on an ironing board. Such a 'sur-real' symbiosis of electronics with the piano proves too daring and is doomed to fail, while healthy reproduction and improvements are also highly unlikely.

1.21 SOURCE VERSUS CARRIER

The Neo-Bechstein's essence boils down to the following: the grand piano, that, by virtue of its musical aspect, can be considered a 'source', was forced by its creator, the physicist Geheimrat Prof. Dr. W. Ernst, to coexist with a technique whose electro-magnetic nature was exclusively designed for carrying music in the guise of variations of current, to speakers, radios, and the like. Source and carrier, production and reproduction, music and playback, are two distinct matters that simply cannot be expected to produce a fertile fusion on an instrumental level. It's as simple as that. Prof. Ernst should have known this right from the start! Or maybe he knew it and therefore did not take his invention as seriously as we do today. All things considered, this should not come as a surprise. Having said that, I suspect that while building and promoting his electro-magnetic grand piano, he was inspired by a certain ideal, just like Mondriaan was when he developed his ideas, a kind of optimism that got in the way of a necessary, and corrective attitude. Let's agree that this is what kept him from realising how impossible his idea was.

So much for the 'Neo-Bechstein' case and instrumental inventors. In the next chapter, we shall have a closer look at Mondriaan's ideas while concentrating on the links between those ideas and the so-called 'compositional supply' by electronic composers that was already briefly mentioned [see 1.3].

2.
DIAGONAL SOUND
From Inert Sound to Projected Sound

2.1 INTRODUCTION

In 1916, the Dutch composer Jacob van Domselaer (1890–1963) and Piet Mondriaan [1.12–1.15] launched the principle of 'static sound' that was to allow them to produce music of 'balanced relationships'. "The inert element (harmony) must take centre-stage, while the 'movement' (melody), despite the dominance of the inert element, must be free to move, and quiet." This is what Van Domselaer wrote in *Het Journaal* of *De Nieuwe Kring* in 1916.

In 1981, the French composer Pierre Boulez (°1925) introduced the concept of 'horizontal arpeggio' based on his key-work *Répons* for six instrumental soloists, instrumental ensemble, and live computer (1978–85). He wanted to reverse intrinsically vertically 'inert' (orchestral) sounds into so-called 'horizontal arpeggios' in real-time (i.e. during a concert performance). Boulez was thinking about the composition of spatial acoustics by subjecting the diffusion of sounds within a given architectural space to compositional laws. By doing so, he hoped that the reverberations produced by sounds in a natural environment would cease to be uncontrollable, thus allowing him to articulate them on a compositional level. Putting this ideal into practice proved more intricate than expected and to pose a number of acoustic and environmental problems. Every time complete 'arpeggio' structures of sound repetitions travel horizontally through time and space, this leads to a proportional, and not always welcome, overkill of sounds.

Between the two extremes — the completely vertical and the completely horizontal — lies the realm of the obscure diagonal. From an ideological point of view, this intermediary position serves no purpose, because diagonal is, after all, a suggestive item related to 'stimuli', such as perspective and crescendos.

Because of this repulsive nature of diagonality, the composer George Antheil (1900–1959) was led to tease the artistic society of his day by exaggerating the significance of diagonal sound in

De Stijl (6th year, 1924), one of the most principled journals. In his article, he confronted the so-called 'verticalists' (composers who build all kinds of complex harmonies, and the like) and 'horizontalists' (composers with a melodic approach) with the diagonal line as a new musical dimension, advocating a kind of acoustic launch of sound rockets to be projected into a room by giant orchestra machines "that can produce a thousand sounds simultaneously" in a diagonal fashion.

For over 30 years, the Van Domselaer and Mondriaan faction — the original verticalists — was supported by the Belgian composer and founder of musical serialism, Karel Goeyvaerts (1923–1993). It was he who, between 1950 and 1955, managed to considerably expand the notion of inert sound. He was thinking of a kind of music without evolution, tension, or drama that could only be composed based on serial guidelines and electronic tools. To this end, Goeyvaerts introduced the notion of 'dead sounds' and said:
"Inert sound structures present an image of unity, the non-moving and non-changing, of the 'being' of time. They need to be captured as non-moving, 'dead sounds'. The ideal dead sound is an electric sine tone."

To put these ideas into practice, Goeyvaerts, in his composition *K5* (1953) built layers of 'pure tones': electric sine waveforms that need to be approached, surrounded and listened to by the interested audience as if they were real 'sound objects', waiting in a silent and inert space.

In *K6* (1954), Goeyvaerts used the principle of chopping off sounds: real 'coups' of 180 instrumental sounds that started and stopped without 'attack' or 'release'. By doing so, he fulfilled Mondriaan's requirement voiced in several publications between 1920 and 1922 about a new ideal sound and sound generation. Here is what Mondriaan wrote:
"New music demands a reduction to the flat, pure, and sharply confined inasmuch as this is possible. It demands a sound generation that does not present this round or closed structure but that reflects to opposing straightness and openness. The limitation of sound is to be found in the sound itself. It is reinforced by means of abrupt stops, in the same that a line of a painting marks and emphasises the border of colour. One sound is immediately followed by the other

— its real 'counterpart'. This 'counterpart' should never be the 'silence' used in old music."

Goeyvaerts said the same using almost the same words:
"Ideally inert sound should appear as a point in a punctual, serially structured composition: as a thump. These sound thumps need to present exactly the same onset and end and must be held according to a specified amplitude. They may neither fade in, nor fade out."

What an impressive realisation of a unique musical concept! And nevertheless it is these ideas that, without Goeyvaerts' intending or even knowing it, provided the basis for diagonalism: the sonic layers of Goeyvaerts' *K5* threaten to crumble under the influence of the listener who comes closer and closer with the intention to look at these sounds not only head-on but also from the side. An almost disastrous situation that forces these monolithic sound objects to reveal their hidden building blocks — layers of dead sine waves — and to put their elements on the table one by one [1.13–1.14]

2.2 SPACE

To get a better idea of how Mondriaan's plastic concepts with respect to a new organisation of sound translate into a more broadly accepted musical terminology, consider a suggestion made by Mondriaan in 1920 to create a space that does justice to 'standing waves'. He has given us a highly idealised idea of this space by talking about an artform located between painting and music. According to Mondriaan, achieving this artform was only possible by means of a new, electric and mechanic, sound-and-vision device. This device was supposed to produce electric sounds in a new sort of room — a 'promenoir' — where a continuous programme was to be presented in a uniform way to akin to the cineac approach. The idea was to have sonic instances alternate or contrast with periods of silence during which images would be projected on the walls. This would lead to the projections being musicalised, while the musical sounds were visualised — through the application of 'horizontality' and 'verticality' to the onset and end of the musical sounds. Mondriaan clearly thought about a room where the audience was free to go wherever they liked, even to the entirely automated buffet and bar. These, too, were conceived and idealised by Mondriaan himself.

It remains to be seen how Mondriaan's sound project was to translate into architecture, how compositions of equally vertical and horizontal spaces could be caused to sound, and how horizontalising standing vertical sounds can give rise to celebrating 'diagonal sound'.

By actually placing these sounds in the room Mondriaan had in mind, we can check whether such well-defined topographic notions as 'horizontal', 'vertical' and 'diagonal' are indeed workable. This approach becomes all the more interesting if one realises that Mondriaan's preoccupation with a spatial representation of sounds and pictures was well ahead of similar developments in post-WWII new music, such as Stockhausen's *Gruppen*, Xenakis' *Poème Électronique*, Nono's *Prometeo*, and Boulez' *Répons*.

On the other hand, Mondriaan's concepts did not come out of the blue — far from it. On an abstract level, Mondriaan started applying the 'De Nieuwe Beelding' principle in 1917, which he later (in 1920) called 'Néo-Plasticisme'. It was both a mental and plastic quest whose purest manifestations were clearly to be found in paintings, but whose ambition it was to spread across the entire social context. In that respect, it is easy to explain why Mondriaan was anxious to find out to what extent his neo-plastic principles could be applied to music as a non-plastic and temporary artform. (To Mondriaan, by the way, the result of this investigation was clear from the onset. It was merely intended to provide a stronger foundation for 'De Nieuwe Beelding'.)

2.3 OPPOSITE SOUND

Mondriaan's idea of compositional structures as well as horizontalised and verticalised sounds according to the spirit of neo-plasticism were directly derived from his mental constructs about 'the opposite' — the 'twoness' — within the new graphic arts. Here is how he put these constructs down in words in the 1921 and 1922 *De Stijl* issues (4th year No.8/9, 5th year No. 2):

"The new (neo-plastic approach) demands mutually exclusive opposites: these contain the annihilation of repetition."

"Old music presents opposites as repetitions. These opposites cause it produce the return of the same elements 'in various ways'. It tries to express this opposition by not representing, by so-called

silence. Such silence simply cannot exist in new music."

"The main requirement for mutually exclusive opposites is the shaping of mutually exclusive twoness. This is a twoness of equals (i.e. squared to the same degree), but there is no similarity."

"In music, sounds are not juxtaposed by similar sounds. A strong sound can be put next to a relatively soft sound, that is completely different. That way, vagueness and monotony are impossible."

"The twoness of the composition is necessary in order to do away with the 'form' that is bound to surface in multiplicity."

"The slightly thin twoness, at least on a theoretical level, never ceases to unite, only to lose itself in the whole."

"When twoness is accentuated as threeness and fourness, or if there is also a 'melody', the ordinary becomes a lot more prominent."

Before looking into 'imaging sound' and 'sounding images' according to Mondriaan's neo-plastic ideas, let us return to what has been said about Mondriaan's preoccupation with new music in the 1920's [1.13 and 1.14]. There, the surprising fact that Mondriaan's preoccupation led to his representation of his ideas in compositional rather than instrumental terms was mentioned. The latter would have been more logical in the light of the situation in his day. On the other hand, Mondriaan's definition of new music was not based on his (rather superficial) knowledge of what composers were doing in those days: it was the expression of his drive to develop a new mental concept on all social fronts.

For the application of originally plastic concepts to inherently temporary music, Mondriaan was forced to resort to in part acceptable, and in part unacceptable transformations of clearly plastic images into clearly musical concepts. In the same way that he, the painter, tried to juxtapose three primary colours — red, yellow, and blue — to achieve a 'pure representation' ("zuivere beelding"), the 'composer' in him was thinking about tone fields that are encompassed by three tones — 'red', 'yellow', and 'blue'. But he went even further. According to a similar principle, Mondriaan wanted to counterbalance these fields with non-tonal fields whose corners relied on a-chromatic noises, 'black', 'grey', and 'white'. Similarly to the opposition of primary and a-chromatic colours, he thus created an acoustic-compositional variant, where sounding tones and noisy

non-tones were to be used side by side. This principle was only developed to its full extent during the 1950's with Karlheinz Stockhausen's *Kontakte* for piano, percussion and electronic sounds (1958).

Yet Mondriaan was not really thinking about organising tones in rows: he was thinking of fields, all the more so since he rejected the flowing, melodic, aspect of music, favouring 'pulses' in the guise of 'tone' blocks without onset or release. Here is what Mondriaan said about this:

"In new music, tone needs to be put side by side with non-tone. Such non-tones must be sounds, but not 'tones'. They must be shaped using sounds (noise) that do not become tones, but whose generation method give them profound purity, interiority, and definition. This new musical concept, the non-tone, shall be a sound that replaces the former 'silence' (...) Tones and non-tones are to be used in a composition that provides a 'balance' between these two. Thanks to this compositional act, the plastic element becomes universal."

Karel Goeyvaerts put it this way:

"Standing sound structures are to be organised as oppositions. They cross each other, they constitute a graphic intersection. Around this intersection, there are structures that evolve in opposite directions rather than to one another."

Mondriaan's idea about the opposition of tones and non-tones in the guise of sequential 'sonic coups' that, "without oscillation or roundness, start as briskly as they stop", though sincere and clever, will always be restricted to sequences of sound blocks in a horizontal direction. This is due to the temporary time element, because those blocks can but be projected in one direction, i.e. that of time. Trying to reconcile the ideal representation of sound fields with the more practical linear temporal progression of sounds, therefore seems to allow for expanding this horizontal structure with a vertical, i.e. multi-layered contrapuntal opposition. All the more so since such a representation of things became commonplace in 1950. Just think of Goeyvaerts who was one of the first to advocate a pure space-time-interlacement, and who said:

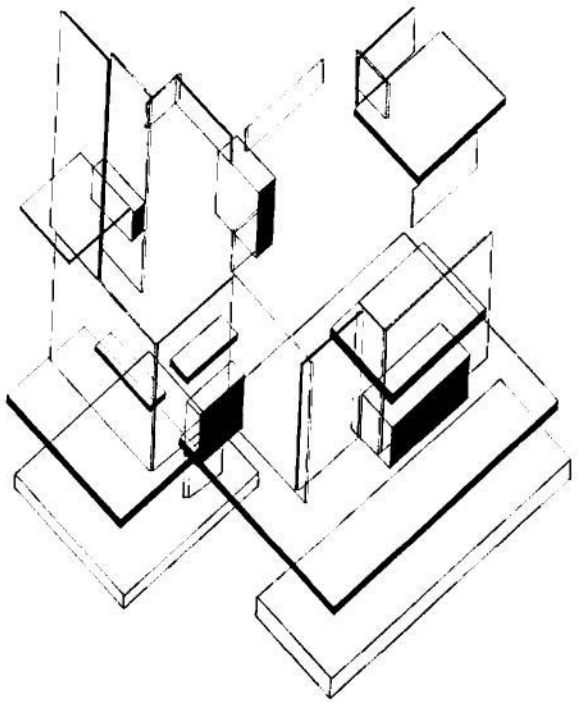
"In new music, the individual sound elements of a composition do not necessarily follow one another; they can also be juxtaposed in various and varying ways."

2.4 DIAGONAL SOUND

A piece of music where sounds are put side by side as equals on a horizontal and vertical level can be represented by means of a flat plane. Such 'flat' music, however, can hardly exist in a given three-dimensional space. Any attempt to do so is bound to create a conflict between the plane aspect of this kind of music with the spatial environment where it is sounded. Coming to think of it, even Mondriaan's over-idealised 'promenoir' remains a three-dimensional space into which two-dimensional sound compositions can only be inserted with great difficulty.

It is interesting to wonder how one should enter such a 'flat' and 'non-spatial' space from a topographic-architectural and acoustic-musical point of view, without getting entangled with the problem caused by the mix of flat and spatial perception. Only in 1922, and eventually in 1925, did this problem lead to an almost unbridgeable divide between Mondriaan and Theo van Doesburg, who, as faithful soul mate and most important spokesman of 'De Stijl', was the one who defended the ideas of 'De Nieuwe Beelding' in the most passionate way. The growing conflict between these two artists is usually — and almost anecdotally — reduced to whether or not one should allow excentric, perspectival, diagonal lines within strictly orthogonal planes. In fact, the divide ran much deeper than that. While van Doesburg never shied away from a dynamic and architectural interpretation of neo-plasticism and was therefore happy to accept the time element as a kind of fourth dimension, Mondriaan rejected this temporal and spatial variant as an unacceptable concession for neo-plasticism.

It is worthwhile noting that Mondriaan's idea of neo-plastic music as a structure of big and small sound squares, separated by equal squares of non-sounds, also contains a number of contradictions. Such a structure indeed tends towards something that has been conceived in a horizontal direction for the simple reason that this representation is mainly inspired by the temporal 'horizontal' aspect typical of music. As a result, the most widespread visual 'image-ination' of a horizontally structured sound sequence boils down to presenting it *en profil* in much the same way as we see trains with a long row of carriages from left to right rather than



Ill. 1

Counter-composition, axiometric project of the 'Maison d'artiste' (1923/25). Theo van Doesburg presented this project, along with two other dwelling units: the 'Maison particulière' and the 'Maison Rosenberg,' as examples of new architectural aesthetics. This project lies somewhere in between flat and spatial, so that excentric diagonal lines abound.

head-on. Mondriaan did not reject such a representation right away. A faithful defender of neo-plastic representation, he was thinking of a flat, i.e. frontal 'visualisation' *en face*, rather than an *en profil* perception, not to mention an *oblique* perception. Yet, sequential structures of sound fields imply the possibility of such rejected representations.

For the sake of clarifying the essence of this question, consider that, around 1920, Mondriaan accused architects of his day of still thinking along the lines of traditional spatial shapes and volumes

while ignoring the possibility of structuring planes. In his opinion, observers and users can therefore never reach the superior neo-plastic perception. Here is how Mondriaan defines this perception in *De Stijl* (5th year, No. 5):

"The new visualisation does not come from one point. The viewpoint is everywhere and not fixed. This visualisation is not tied to space or time (...) Old architecture uses shapes and volumes. The new visualisation sees architecture — a multitude of planes — once again (as) planes. This multitude therefore composes itself in an abstract way — to a flat image."

The importance of this utterance for the present subject lies in the fact that, as we will see later on, is its perfectly usable for the 'architecture of sounds'. Let us first wonder, however, how the traditional spatial position of musical observers allows them to perceive rows of Mondrianic sound blocks. Is the sound train with its acoustic carriages not forced to ride straight at the straddle-legged observer in order to meet Mondriaan's neo-plastic idea about music in the best possible way? That remains to be seen, because this representation poses other problems. The train emerges on the horizon, yet Mondriaan's refutes depth. A dilemma.

Yet the answer to all these question is affirmative if we agree to expand Mondriaan's neo-plastic idea about structuring sound in a linear direction with the 'field' concept. Such a field should be seen as a structure that not only comprises horizontal sound rows, but also vertical sound columns. Every segment of a sound row is followed by a sound column that does not stand on end: it stretches into depth. On other words: behind each sound field lies a sound column. The sound field masks the column. The total number of sound shapes is composed in orthogonal fashion, whereby the vertical and 'deep' are equal to the horizontal. And there is more. To clarify this, let us have a look at the question of representing sound by means of graphic and architectural shapes.

2.5 VISUALISED SOUND

As stated earlier, the problem of the impossibility to express time elements by means of plastic shapes boils down to the illicit (even for Mondriaan) transformation of visual representations into aural equivalents. They are illicit in that sounds, whether by accident or

intentionally, are considered concrete, spatial entities, which they are not. Sounds are not palpable objects, they are acoustic 'reports' of physical phenomena. And those reports are always linked to time. While an object can move left or right, sound cannot. While objects can fall and rise, sound cannot. While one object can cover up another, one sound may be capable of masking another, but it can never cover it up in such a way that the second is eliminated. (Make no mistake: by using electronic tools, you can modulate one sound with another, but this is an apparatus-linked and thus objective instrumental mechanism rather than one sound modifying another. To put it differently: sounds do not 'work', they are the result of something that is at work.)

Visualising and mechanising sounds have proved indispensable under certain conditions, not least in the long tradition of music education. The use of visual representations aimed at coming to grips with the interaction of tones can be traced back to music education in the early Middle-Ages, more specifically as a part of an extensive mnemotechnic and notation method. (The term 'scale', for instance, which is still used today, is derived from 'steps' that were drawn in order to show medieval students how groups of musical notes can literally rise and fall in hexachordal series.) It is therefore safe to say that the evolution of the entire polyphonic music culture was only possible thanks to those basically regressive visualisations and tonal relationships. The simple fact that, once musical notation had been established, it became perfectly possible to write down musical curves not only sequentially but also one below the other, meant that melodic material could be manipulated in the sense that you could repeat and imitate it. When it reached its prime, this system allowed for counterpoint, canons and fugues that quickly became autonomous formal disciplines.

(It is interesting to note that the term 'fugue' is derived from 'fugere' = to flee. Given that a vertical human body that is forced to run away in a horizontal direction will naturally assume a diagonal (45°) position, the fugue as a kind of 'escape' appears to be the ideal way of creating diagonal sound formations: sounds arranged diagonally below one another, chasing, overtaking and overlapping one another. In the light of the definition of 'diagonal sound' as defined above [2.4], the fugue's diagonal

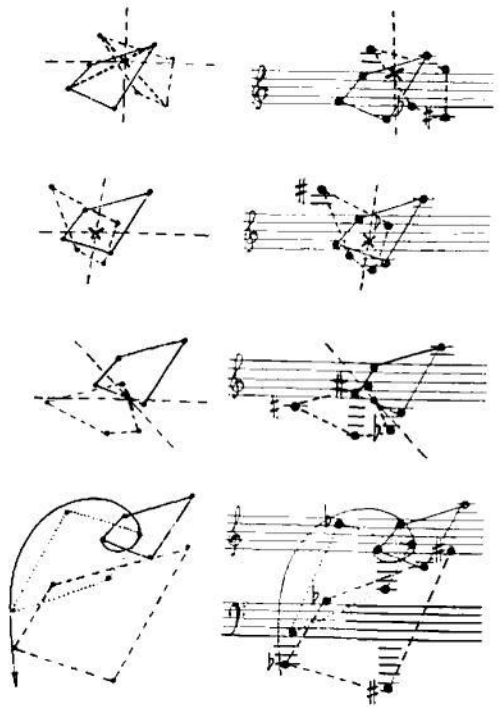
arrangement may therefore be worthwhile remembering.)

In conclusion, visualising musical sounds, and hence representing them by means of palpable shapes, allows one to work with topographic terms such as high, low, above, below, before, behind, and strong in the process of subjecting formerly incomprehendable sound to operative, almost mechanic, actions involving tools. Sound can now be repeated, enlarged, reduced, reversed, mirrored as though it were a palpable substance rather than a 'language'. In that respect, polyphony can be said to be the art of uniting and horizontalising, verticalising and diagonalising sound. (I would also like to emphasise the term 'counterpoint' that is not merely about placing points opposite other points — 'punctus contra punctum' — but also one after the other, in a mirror fashion, inversion, and crab movements.)

2.6 INVERTED SOUND

One of the most elementary operations sound can be subjected to is its inversion, even though this ostensibly simple operation is far from easy. Sound can indeed not be inverted as long as it is tied to the kinetic source that produces it. The way sources, from waterfalls to explosives, work cannot be inverted. A sound must therefore first be detached from its source and become independent in the sense of a reversal. And even in those exceptional cases, it is not the sound that is inverted but rather its carrier. (Just think of a tape that can be played backwards, while the sound itself cannot.)

Whenever sound comprises a melody, such a unit contains three elements: a linguistic, a graphic and a sonic aspect. The question then is which of these three can be inverted and also how this can be done. In the first case, the melody's syntactic structure should trigger an internal mental representation whose result is then reproduced backwards by means of vocal or instrumental sounds. Language is thus transformed into sounding singing or speech in the 'inverter's' mind. Not the easiest form of mental gymnastics, one should say. The second approach seems more promising: invert the curve of a progressing melody by writing down a series of notes. By reading and performing these notes backwards, the melody is reversed. This allows you to read the sequence C-D-E-F-G as G-F-E-D-C, in which case it has been rotated 180° so to speak.



Ill. 2
Graphic representation of a rotation and translation of note clusters. Mauricio Kagel, Translation – Rotation, *Die Reihe-7, 1960 (with the remarkable motto by Paul Klee: 'Form = nature morte'.)*

An interesting and somewhat provocative question is whether it is also possible to rotate such a series of notes in other directions. The answer is yes, provided the image is being used as a palpable graphic object, an object that is literally rotated around its axis (whereby the 'E' in the above example would be the centre) and whose result can be projected onto a conventional stave. In that case, one would not actually rotate sounding 'tones' but graphic 'notes'.

Applying the notion of 'inversion' to the sonic aspect of a

melody — the third way — leads to a number of complications. To describe them, consider inverting text, because text (or lyrics) present a tight relationship of linguistic and melodic elements (phrasing, diction, punctuation, etc.). There are two possibilities for inverting lyrics: you can invert the sound of the lyrics or their graphic representation. In the latter case there are again two possibilities. Suppose we reversed the sentence "This sen-ten-ce will be in-vert-ed". This would lead to "Ted-ver-in be will cen-ten se this". Reversing the order of the individual letters, however, would yield "Detrevni eb lliw ecnetnes siht". Pronouncing the sounds of this sentence backwards causes a number of fundamental linguistic-kinetic problems. The letters d, k, p, q, t can indeed not be inverted, for they are plosives with a one-way sonic evolution that is tied to kinetic sound sources and therefore cannot be changed.

What is possible, though, is to record the required text on tape and play that tape backwards (rotated by 180°). Thos has already been mentioned. Here again, rotating a magnetic tape by 90° is unimaginable because the tape is a two-dimensional medium that can only move forward or backward. (As such, this remark serves no purpose. It does help to understand, however, what kinds of transformations from one shape to another are feasible, and why others are not.)

Note. A primitive, imitative attempt to produce retro speak can be found in the 1984 video production *Come on Petunia* by the English video artist Gary Hill. The title is an anagram of 'Once upon a time' and based on Lewis Caroll's *Alice in Wonderland*. Another attempt to produce the most consistent possible, even though almost impossible, retro speak performance was made by myself in 1986. It was called *The-o van Vel-zen*. There, the voice sounds were subdivided into their smallest imaginable components, and then 'reversed' several times by means of a tape machine. The result was both 'real' and artificial.

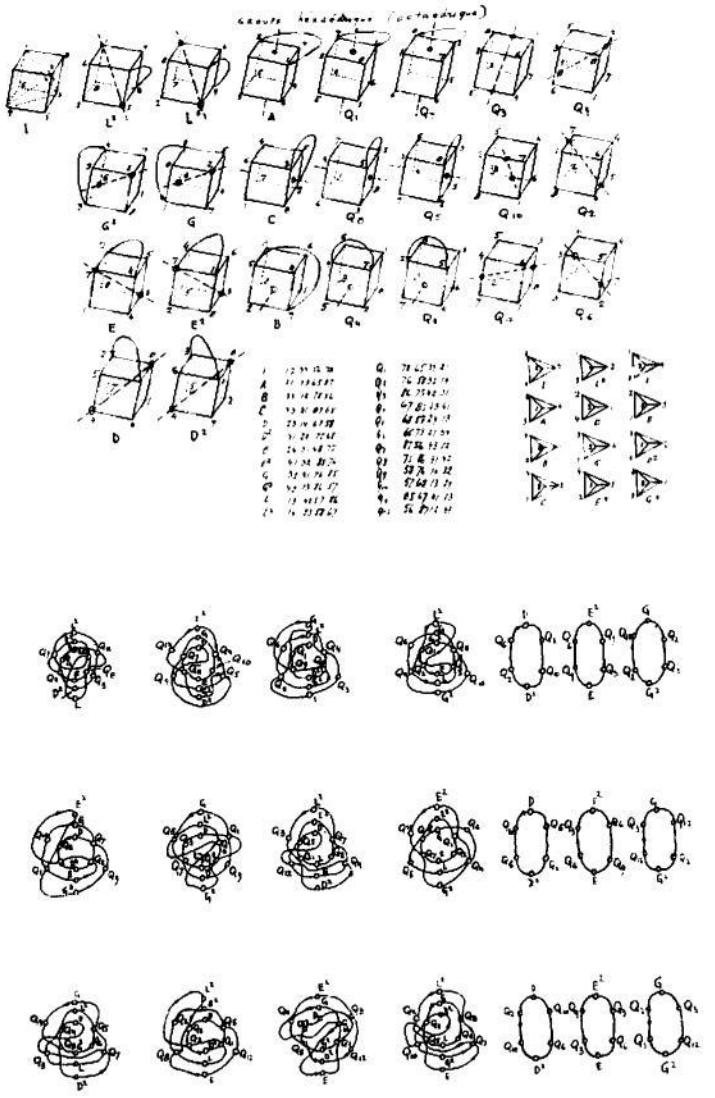
2.7 MONADIC SOUND

Even though tonal relations are usually represented by means of linear shapes — melodic ones in a horizontal direction and harmonic ones in a vertical direction —, certain situation may call for combinations of these two directions. We are then talking about graphic 2D circles or spatial 3D configurations you can rotate as

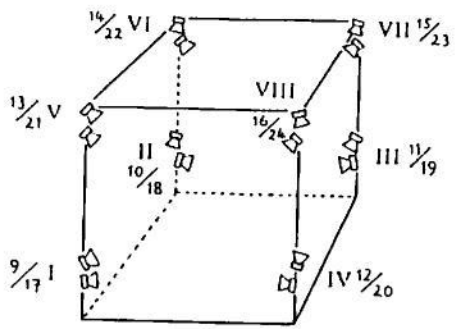
though they were musical 'monads', project and cross in much the same way as rebuses, magic squares, tropical systems, palindromes and tone bells. By linking such 'curved' note images to such hermetic-cosmological representations as heaven, earth, water, stars, planets, gods, measuring scales, numeric systems, and so on, (Athanasius Kircher, Robert Fludd et al.), you can suggest certain profound and mysterious meanings that go way beyond the mere act of singing or playing those notes on straight staves.

Note that visualising musical sounds by means of musical monads is not only a thing of the past: it proved an indispensable representation tool for post-WWII music. Such tools not only allowed for the emancipation of 'performance music' but also for expanding the predominant pitch unit with parameters such as tone colour, duration, dynamics, material and technique. In exchange for reaching this goal, those musicians gladly accepted a regressive reliance from 'signs' to 'drawings'. Some of the countless telling examples from those days are the rotating cubic hexaeders as used by Iannis Xenakis in *Nomos Alpha* (1965), a kind of 'octophonic' structuring of space in Karlheinz Stockhausen's *Dienstag* (1991), and the so-called *Ton-Raum* manipulations by Walter O'Connell in 1962.

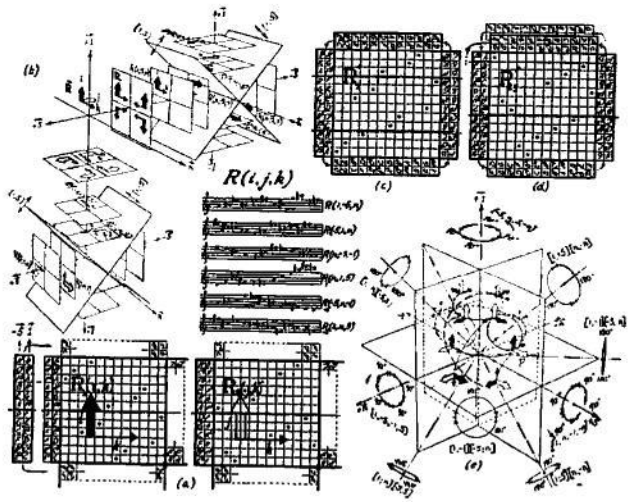
In a suggestive way, the 'Rotation' diagram by the American architect Peter Eisenman seems to comment on the way in which Walter O'Connell dealt with the relationship between 'Ton' and 'Raum' from a musical point of view in 1962. Eisenman's 1992 drawing (which, at first sight, reminds one of the design of a new fancy-fair attraction rather than a solid, deeply rooted construction) provides the foundation for the double oval skyscraper whose upper part becomes entangled: the gigantic 'Max Reinhardt Haus' located in downtown Berlin. While, to Eisenman, this diagram provides an inspiring booster whose contents does not need to be converted into concrete construction volumes, O'Connell's drawing is a stimulus for visualising an imaginary, 'impossible' 'Ton-Raum' relationship. From the point of view of their stimulating functionality, the two 'salto mortales' have a lot in common. Both representations indeed voice a deep desire for the realisation of fleeting, gravitation-free states of earthly things. While



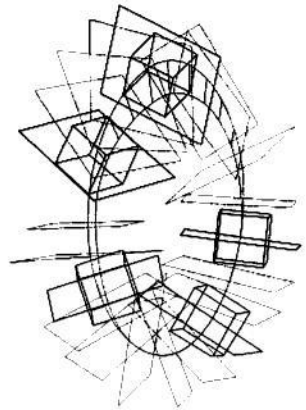
Ill. 3
Graphic representation of note configurations that can be manipulated: hexaeders in Nomos Alpha, *1965, Iannis Xenakis*



Ill. 4
Octophonic space, Dienstag aus Licht *(1991), Karlheinz Stockhausen*



Ill. 5a
'Ton-Raum' *manipulations, Walter O'Connell (Die Reihe-8, 1962)*



Ill. 5b
Diagram system by 'Max Reinhardt Haus' (1992) in Berlin, Peter Eisenman (1932)

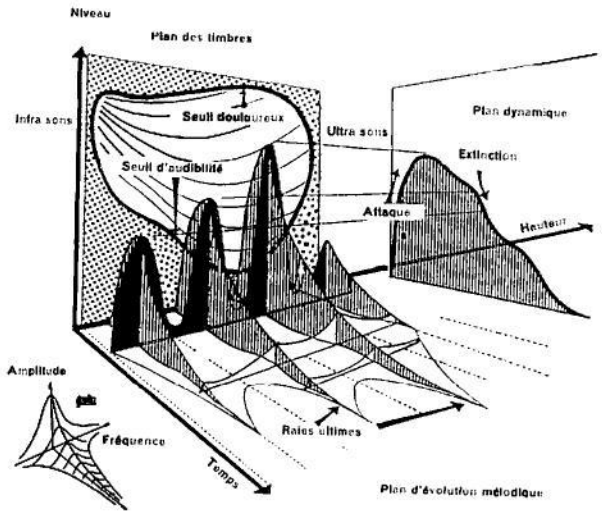
Eisenman deals with massive construction material, O'Connell uses musical tones that, once you liberate them from their rigid, straight tone scales, are able to carry out direct three-dimensional spatial movements. (Note. See chapter 4 for the significance of visualising sound dimensions with respect to 'movements' by architectural volumes.) [4.21–4.23]

2.8 LAYERED SOUND

Armed with the above examples, we can now return to expanding Mondriaan's time-structured sound fields with various spatial fields of equally important sound rows and sound columns. As stated above, such sound fields, in their new capacity, have not only with height and width, but also a volume in the sense of depth. Behind every sound plane lies a series (or 'arpeggio' as Boulez would call it) of uniform and literally homophonic copies of that one mother plane. Let's agree to call the total number of such layered sound fields, including the front-most field, an 'acoustic aggregate'. Such an aggregate is to be considered the ideal neo-plastic sound: flat and yet deep, without perspective or vanishing point. The front-most plane of every sound aggregate represents the visual and audible 'sound coup' as Mondriaan calls it.

The observer who, according to the neo-plastic rules, stands right in front of such a structure, has no notion of the copies behind the front-most planes. He only hears what he hears, i.e. the front-most planes he faces.

Even though, in the process of tilting those aggregates, the front-most plane may be repeated by a replica behind it, that does not mean that the structure of the aggregate in question is uniform. Quite the contrary. Even though the mutual distance of the hidden planes *can* be regular (the positions are then equidistant because they are periodic), other distributions are by no means impossible. A regular repetitive collocation of planes is indeed only one of many distribution methods. Consequently, the more this distribution is composed, the more complex the internal mor-



Ill. 6

Sound object, Abraham Moles, ca. 1960. The visual representation of this sound object suggests a layered sound structure. Here, however, the sound layers are harmonic spectra that do no really exist. Harmonics (or overtones) only exist through analysis in the same way that white light will only be perceived as a synthesis of a number of primary colours once you start analysing it, even though that is not really so. Moles means analysis, but suggests synthesis.

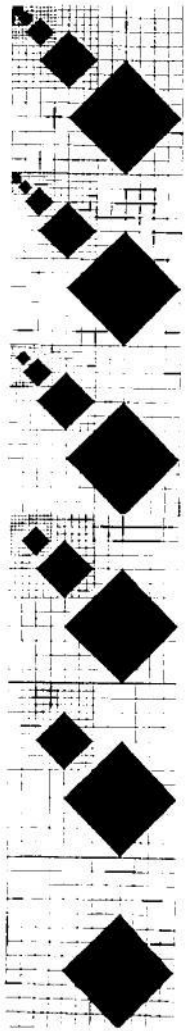
phologic structure of the aggregate in question becomes, so that the total number of layered planes becomes an amorphous whole. By analogy, such a way of composing grants the repetitive structures of Boulez' 'arpeggio' a depth that can be perceived as being completely horizontal given an extremely oblique perception. That is why Boulez' term 'horizontal arpeggio' is so meaningful in this context.

Structuring layered planes leads to a better understanding of timbre than what we have come to accept. In a conventional sense, timbre refers to a characteristic of a sound which, no matter how mobile it may prove to be, is an 'outside' element that evolves in linear fashion and is glued to the skin of a sound. If a sound is a layer of several planes, timbre is about an active potential of the sound aggregate in question that, once its time has come, can spread spatially, literally encompassing space and filling it. It goes without saying that the latter not only takes place in an obscure, 'ambiophonic surround'-like shape but also in a 'compositional' way in the true sense of the term. (See also the next chapter about 'composed sound'.) This concept therefore connects Boulez' concept of 'horizontal arpeggios' with the ideals of Mondriaan's more primary 'standing sound'. The proof that such a reconciliation is possible through diagonalising standing sound is worth noting.

2.9 LAYERED SOUND 'FROM THE SIDE'

A periodic sound is generally presented as a string of similarly shaped wave patterns that move through time without interruption. As soon as these periodic movements stop, so does the sound; or at least, that is what we think happens. From a neo-plastic point of view, however, there are no moving waveforms (both concepts, i.e. 'moving' and 'waveform' as such are already irreconcilable with neo-plasticism), but only standing, motionless planes that are not even organised sequentially but in rows. Such layers of planes all present the same aspect and, as stated above, could thus be considered copies of one another. This reminds us of the sequentially laid-out waveforms of periodic sounds that, in a sense, might be called copies as well.

If an observer decides to change his position with respect to a series of aggregates, he will 'see' them from the side, so that the



Ill. 7
Theo van Doesburg, Six moments in the development from plane to space (1926/29)

planes behind the front-most planes become audible as though they were the individual elements of a fan. It then appears as though the aggregates are tilted with respect to the observer, so that the various sound planes are no longer masked by the front-most ones and become audible. Mind you, it is not the aggregates that change their position, it is the observer! After all, he is the one who moves and thus changes his position, the sounds do not!

This leads to the representation of a series of sounds as aggregate fields: three-dimensional sound spaces the observer can actually enter and cross from an acoustic point of view. This observer can choose this kind of observation without jeopardising his original idea of a head-on position. There are no longer lines that run into depth, just purely frontal projections of the total field of 'standing', undynamic planes. And that is how Mondriaan's neo- plastic sound is brought about: it is not a fixed objective item, as would be the case with conventional sounds; it is a flat, but nevertheless layered, structure that has the potential to spread in space during observation without the requirement that space should imply a certain degree of depth.

An interesting analogy with the representation of layered sound. Van Doesburg is looking for a dimensionalised 'forme universelle', where one single layer — a square plane — proves to consist of multiple layers and to have the potential to evolve in space. This space is therefore an intrinsic quality of the plane because it is hidden from the eye. Through a kinetic, not to mention cinematographic, representation of this plane, this hidden aspect is revealed. The question, however, is who and what moves in a kinetic sense: Doesburg's artist or 'we'? Ideally, this would be 'us', but alas — or rather necessarily — van Doesburg is the one who moves, this time in a capacity of film director. In six picture stages, he shows the release of a proportional number of pic-

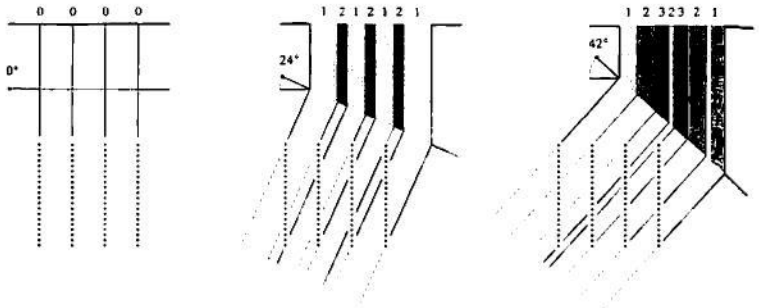
ture layers that are located behind the first plane so to speak. (It strikes one as telling that this temporal revelation of spatial shapes was presented by van Doesburg as a kind of film tape at the occasion of the publication of his article *Film als reine Gestaltung* (*Film as pure shaping*) in the journal *Die Form*, IV/10, 1929.)

2.10 PROJECTED SOUND

As stated earlier, a collection of several sound aggregates, when looked at from the front, constitutes the ideal neo- plastic sound field. Within this field, the sound aggregates are organised as equals on the horizontal and vertical axes. Such a field is an acceptable visual model of neo-plastic music, but it is not the music itself. It is, however, an inspiring model that, at a conceptual and graphic stage can be instrumental for the composition of neo-plastic music in the same way that it helped us to come to grips with this kind of music. Even so, the model cannot be made to sound directly. Once we accept this restriction, we will have little difficulty accepting the above [2.3 and 2.8] and to summarise and expand it as follows.

A field of aggregates is represented by means of a matrix. Like every matrix, it consists of rows and columns: the rows are the aggregates' 'front-most' sound fields, whiles the columns represent the layered, 'underlying' sound planes. The rows need not necessarily lie on one line but can reside anywhere in the plane. What remains are the columns that represent the composed 'depth structure' of the aggregates. These columns therefore need not be in an erect position, they could be distributed in depth. In order to read the matrix on a flat plane, it is projected orthogonally on a so-called loxodrome as a 'sum line'. This sum line crosses the matrix in a straight or diagonal direction. The sum line's angle with its abscissa is on the reading (perception) angle the reader of the matrix assumes with respect to the sound space. (Note: in 1954, Goeyvaerts signalled the existence of a loxodrome that crosses everything, and called this a "a cut through spatial, virtual reality". In his opinion, this 'virtual reality' consisted of a 'constellation of parameters', while, in our case, it is a constellation of layered sound planes.)

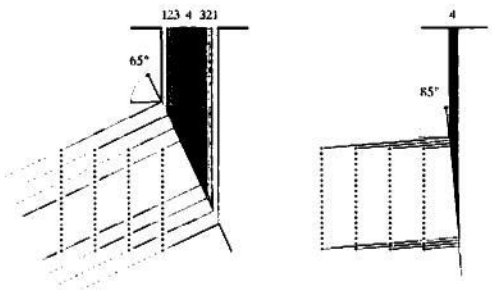
When looking at such a matrix *en face* and reading the summary line from left to right, the density of the matrix is experienced as



Ill. 8
Five different readings from different 'reading angles' of the same sound matrix. The angles are: 0°, 24°, 42°, 65°, and 85°.

a constant. By looking at the matrix *in an oblique way*, however, the reader sees the so-called spectral bands that determine the structure of diagonal sound. These spectral bands are subject to interference because of the uniform aspect of the repeated fields. A matrix with evenly distributed fields contains three such bands. At the first band, the density goes 'crescendo' in such a way that the density increases uniformly. This is the 'phasis band' (in astronomy, 'phasis' refers to the appearance of a celestial body). The central band is the 'tropè band' ('tropè' means shift or turn). The third band, that necessarily goes decrescendo, is called the 'dusis band' ('dusis' means disappear). The more complex the structure of the matrix, the more complex the spectral bands (number and density). [4.8]

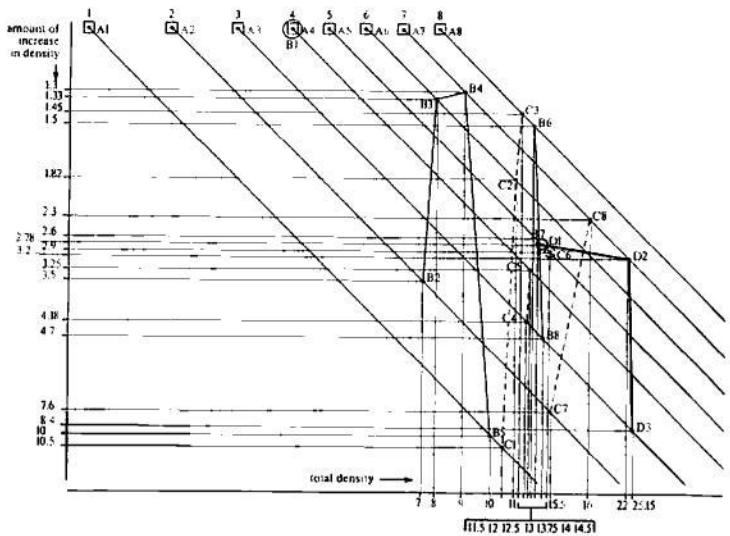
An observer who consciously moves within the field of aggregates projects this field on a plane: his 'perceptive plane'. That plane is where the 'image' of his perception materialises. While the image can be communicated to the outside world, the perception itself cannot. There are several ways of projecting fields onto perceptive planes. The most obvious one is the frontal one, i.e. *en face* with respect to the sound aggregates. The second is from the side, i.e. *en profil* with respect to the same aggregates. Then there is also the extension of these two 'positions' that crosses the sound space



diagonally. As stated above, the third projection creates the illusion that the corresponding aggregates are tilted. This is a dynamic interpretation of sound, a way of looking at it that is banned from the neo-plastic construct. In reality, the tilted diagonal projection acts as sonic 'report' of the intersection operation the observer has just performed. That report is communicated by the observer to us — we who are standing next to the field. Despite this position, the report will be intrinsically frontal, unsuggestive, neither epic nor narrative.

2.11 SOUND AS A REPORT

A sound field organised like a matrix is 'read' by the observer in way comparable to how a walker walks through a forest. Most walkers follow a hiking route. So does the musical observer. The latter has a map that tells him how to approach certain sound aggregates, only to turn around them once he is there. The observer then makes a report of such hikes and observations for those who do not move or turn about. Making a report means that the observer makes the way in which he has experienced the tilting of aggregates from different angles audible — talking about his frontal and diagonal impressions. By sounding his report, he only brings one single aspect of the total sound field's structure to life, as is the case during a walk. The more walks he makes to verify his previous experiences, the better he will be able to produce a faithful and valid global picture of the sound field's structure.



Ill. 9
Diagram of three walking programs derived from the composition Canon-1 *(1964), Dick Raaijmakers*

Three hiking routes have been devised in a diagonal-line field of eight aggregates: A1 through A8. The first comprises three parts with one, four, and three 'stop-overs': [B1], [B2-B3-B4-B5] and [B6-B7-B8]; the second has four parts with three, two, one, and two stops: [C1-C2-C3], [C4-C5], [C6] and [C7-C8]; the third walk has but one part with three stops: [D1-D2-D3]. Each stop represents an encounter of the walker with one of the eight aggregates. Depending on the route the walker follows, he may meet the aggregates ad random, and even repeatedly.

In this example, the aggregates are subject to constant changes, while they also rotate around their axis at a constant speed. This means that their direction and 'reading angle' change all the time. The numbers on the Y-axis of the diagram correspond to the speed of change. When the walker who takes the B route reaches aggregate A2 at stop B2, that aggregate's state will be 3.5. If the walker than continues, he will meet aggregate A6 at stop B3 which will

be in its 1.33 state. In the same way, he will encounter A7 at B4 in state 1.3, and finally A1 at stop B5 in its 1.0 state. At each encounter, the walker's viewing angle will relate to the direction in which the aggregate in question moves, so that both directions are fused into one. The same happens during the two remaining strolls.

(Note: in sound fields you can walk through — of which there is only one in the above, albeit extreme example — the aggregates may, or may not, assume various changing shapes. In *Canon-1*, the sound layers that constitute the aggregates increase uniformly, while the aggregates in the example (see the above illustration) are units never changing, that, like planets, rotate around their axis at a constant tempo. In these two cases, the common factor is the walk as a musical excursion.)

Each walker chooses his own route, which, by the way, is a prerequisite for graphic and architectural works of art. After all, the work of art is hanging on the wall or standing somewhere, while the walker, in his observing capacity, walks around it. This is quite unlike the perception of conventional music with its epic predilection for melodic, harmonic and rhythmic elements. There, a whole series of intrinsic acoustic laws make such a freedom of movement impossible. (A 'holophonic' sound space would be ideal, even though the current electro-acoustic situation turns this into a dream.)

Because of that limitation, composers of conventional music are used to making such walks on behalf of their collective audience in order to report to their listeners about their favourite routes, their experiences and observations. To this end, they write down their routes as scores with a high degree of precision, as though they were 'hiking routes'. Conductors and musicians read these score and, by doing so, follow the routes (the actual compositions) suggested by the composers by repeating the composer's walk. The audience stays 'at home' and listens to what the conductors and interpreters have to say, and so forth. Alas! such an approach is not particularly democratic, but it is the only way for this kind of music.

2.12 WALKING AS AN ART

Or is it? Not if you accept a shift in the hierarchical position of the composer, his score, its performer and the listener. In that respect, it may come as no surprise that a large number of post WWII avant-garde artists rejected pre-defined, 'recommended' hiking routes. They preferred to leave the intersection of geographical picture and sound planes to the viewers or listeners themselves. It is thus no longer the artist's job to devise well thought-out pictorial or musical walks, but rather to create landscapes where we — the walkers — can dwell. Such a new artist thus no longer provides detailed routes: only rules for the way in which we can walk through the geographical planes. As a result, there can be as many routes as there are walkers, and as many acoustic or plastic works of art as the number of listening and watching routes. That way, art hits the street (to put in 1960's terms) with a completely democratic way of practising art in general and music in particular. This is an ideal formula that can be 'performed' but not yet, or only partially, put into practice.

As far as music is concerned, conventional walks, where the composer walks ahead and the listeners follow, have a number of advantages that are absent from improvised walks. Improvised walks mainly clarify the positions of the sounds within a sound field, and the visitor's location with respect to those sounds. Conventional walks, on the other hand, deal with the internal structure of sounds in a much more refined way than could ever be achieved by the outside of the sound bodies themselves. The walking artist 'explains' and 'describes' the setting as a work of art down to the finest detail. During a democratic walk, the listener never gets to notice such details: from a hierarchical point of view, he is untrained and only wishes to walk, and is thus quite happy to accept this limitation. He is, however, an emancipated walker, free to make his own choices, secure in the knowledge that he knows what he is doing. Ideally, the best possible balance between these two kinds of walks and hikers, and thus between the actual and artistic dimension of such an enterprise, is what one should strive for. And again, the quality of a work of art depends on finding the right balance between these two.

2.13 A NEW MORPHOLOGICAL SOUND

During the 1920's, Mondriaan and his soulmates were certainly not looking for balances, in the sense of concessions, but rather trying to achieve an absolute balance between opposites. It is precisely this kind of balance that, due to its obscure temporality, is very difficult to achieve in music. Nevertheless, the sincere quest for neo-plastic music was worthwhile, all the more so since an unexpected sequel to these attempts suddenly emerged fifty years later. Think of the act of composing hybrid, liquid and rounded arpeggio-like sound shapes and sound volumes using advanced computer tools that were supposed to replace static standing sound planes. Though ostensibly far removed from original neoplasticism — just think of its terminology —, they are in essence the only alternative for the three-dimensional perspectival music of yore. While the latter was chiefly handmade and thus 'instrumental' in nature, the new approach favours a partly conceptual-compugraphic, partly architectural-compositional specificity by virtue of which it can go way beyond our traditional understanding of 'sound'. This approach will be discussed in the next chapter, called 'Composed Sound'.

3.
COMPOSED SOUND
From 'Plaque Fixe' to 'Horizontal Arpeggios'

3.1 INTRODUCTION

The previous chapters dealt with two kinds of electric sounds: a sound 'invented' by instrumentalists, and sound 'composed' by composers that is not related to an instrumental way of generating it. While, from a morphological point of view, instrumentalised sound proved to be purely linear and single-layered, i.e. perfectly flat, composed sound managed to express compositional intentions and to assume spatial dimensions.

The idea about electric sound as neo-plastic means that Mondriaan developed in his writings and debated during the 1920's allowed us to juxtapose the two aspects of such sounds — their vertical and horizontal dimensions. This was all the easier since Mondriaan had clearly opted for composed sound, even though his background had conditioned him — and quite understandably so — to use the terminology of instrument manufacturers. In order to clarify Mondriaan's intentions and principles, it was suggested to literally expand his neo-plastic world of planes to aggregate structures of uniform and similar sound planes.

Before trying to isolate spatial analogies of such aggregates in electronic music and, by extension, in computer graphics of contemporary architecture, let us discuss the concept of 'image'. This term will be used in a social- hierarchical rather than a technical sense. More specifically, let us look into the analytical intentions of a man who pioneered cinematography — the French physiologist and motion specialist Etienne-Jules Marey (1830–1904) — by committing human and animal movements to fixed carriers, his so-called 'plaques fixes', via layers of photographic sequences. His achievements and intentions provide the starting point for a new definition of spatial morphology, albeit with respect to instrumentalising and 'composing' future acoustic, visual and architectural shapes.

One of the main representatives to develop this morphology for

music is the composer Pierre Boulez. It was he who, around 1980, introduced the 'horizontal arpeggio' principle [2.1]. In this chapter, we shall deal with spatial distribution of uniform sound planes from two angles: first, as a variant of diagonal tilting of Mondrianic sound aggregates and, second, as a sequel to layering photographic images as practised by Marey. As stated in the introductory chapter, point-shaped sound structures I studied and developed from methodological and deductive way in the 1960's, will also be discussed. The morphology of that endeavour indeed provides an excellent model for all subjects that have already been and probably will be covered in CAHIER-M in the future.

3.2 IMAGES

The world around us can be literally represented using technical images of it. If we accept to call the total sum of all states the world can be in the 'actual world', the total number of all technical images would be the 'represented world'.

The actual world is by definition three-dimensional, spatial, while the represented world is two-dimensional, represented by technical means and thus flat. While the actual world is substantial, one-shot and unique, technical images of the represented world are a matter-less 'retina' (photographs, film, tape, magnetic memory). Tanks to their immaterial nature, these pictures can be freely distributed and reproduced in space and time (visual communication technology).

If exceptional pictures of the represented world prove to be spatial rather than flat, they become a new kind of actual world. In that capacity, they copy the real world (replica, scaled models) or are simply a part of it (art).

3.3 GRAPHIC REGISTRATION

Pictures of the actual world are obtained by means of photographic and phonographic techniques and committed to image carriers. Mind you, it is not the world itself that is being 'recorded' but its movements and contours. These pictures are obtained by putting technical devices between ourselves and the actual world. The devices contain media capable of recording the desired images in an objective and true-to-life fashion. To this end, the images are

literally 'written' onto a medium (in the sense of 'engraved'). Marey introduced this method in 1878 an called it 'La Méthode Graphique'. The term 'true-to-life' implies that the device manages to represent the world as it is, without distortions of any kind.

These technical tools allow us to represent the actual world by means of pictures. Let us agree to call this an 'apparative registration'. It comes in two flavours: analogue and momentary registration. Analogue registration means that the apparatus faithfully follows the world's movements in real-time, without interruption. The pictures thus gathered are carried by linear traces (ink, light, or sound) that move in time at a constant speed. Momentary registration, on the other hand, results in a series of discrete images (photographs, film pictures, television pictures) that are recorded sequentially rather than juxtaposed. The time factor is halted so to speak, which allows one to subdivide a continuous movement into discrete stages.

Both methods for gathering pictures allow for the synthesis of new movements. If the movements run in sync with the original world, they are faithful replica of that world (a documentary). If the pictures are autonomous, however, they constitute separate, 'picturesque' worlds with their own reality and sets of values (computer technology, graphic arts, 'virtual reality').

3.4 HIERARCHY

Each transformation of a spatial world into flat, 'picturesque' images of that world is carried out according to a three-stage 'hierarchy'. The first stage is, of course, the first world, the second is the technical image carrier and technical recording device, while the third stage is the observer who reads the images of the second stage — the media.

During this registration, each stage can follow its own, independent, movements that are in no way connected to those of the other stages. Yet, it can also be still. Stillness and movement are thus the two 'states' each of the three stages can be in. It follows that the registration act involves a total of three times two (i.e. six) states in various configurations. Each configuration is a mirror image of the kind of hierarchy and the kind of *session* that lies at the heart of the registration, but equally of the reproduction of the

world. The selection of a given configuration is determined by the degree to which the three stages should correspond to one another.

Let us briefly look at four such 'states' the stages of our hierarchical system can be in during the registration or reproduction process. The first two are linked to the registration stage, the remaining two to the reproductive stage.

1. There are two possibilities for registering the movements of a moving object: the carrier either moves, or it is anchored, still, in a fixed position. The second approach guarantees a faithful registration of the object's movement. That is why, for scientific registrations of the movements of a living body, the camera is to remain in a fixed position. Movements of the camera would indeed lead to mixing two kinds of movements: that of the object and that of the registrar, the result of which is no longer 'faithful' but ingenious. (In motion pictures, where both the actors and the cameras move, the resulting movement reflects what the director had in mind. It is he who takes the credit for interesting viewing angles, cuts, and so on.)

2. If the object to be registered lies still, there are again two possibilities: the registering carrier does not move either and remains in a fixed position (photograph of a still life, portrait photograph, amd so on), or the carrier moves and changes positions (a spacecraft that flies around the moon, a police camera that registers a house's interior after a burglary, an so on).

3. The third possibility is linked to the way in which the pictures played back, whereby the carrier — and its pictures — move, while the observer does not. As such, the film reel, in its capacity of image carrier, moves past the lens of the film projector at a constant speed, while the people in the movie theatre remain completely motionless. (Except perhaps for the short walk to the box office, finding a seat in the theatre and sitting down. The audience paid for the comfort of sitting still. If this condition fails to be met, the entire session bursts like a bubble, and the audience asks its money back.)

By the way, the etymology of the Dutch word 'bioscoop' (for movie theatre) clearly indicates the hierarchical relationship between the filming device and the movie goer. The same is true of its predecessors, the stroboscope, the zootrope, and the traumatrope. 'Bios' = life, 'skopos' = the one who sees, 'strobos' = turn around, 'zoo' = life, 'trauma' = wonder, 'tropè' = turn around. These words not only state that pictures move, but also indicate how they go about it. For an optimum photokinetic effect, the observer holds his head and eyes completely still. It strikes one as significant that the magic lantern — the 'laterna magica' — should be *the* symbol for causing a series of picture carriers to move without the need for the person who watches them to move. The magic lantern ('magic' sic!) may therefore be regarded the direct ancestor of modern-day 'peepshows', whatever the lantern operator's efforts to link the pictures together by means of all kinds of edifying stories.

4. Let us now consider an inverted hierarchy: the media is still, while the observer comes and 'deciphers' the carriers at his own pace. This seems to indicate a scientific, or at least analytical, attitude on the part of the observer. He is not looking for a synthetic presentation of movements where he himself can sit back at leisure (comfy chair, movie seat), but rather wishes to analyse pictures, where the pictures remain still, while time and the observer are in motion. On example of such a hierarchical 'state' is a computer user who loads (reads) information from his hard disk [3.6].

Another telling example is that of a medical radiologist who looks at and studies tomographic MRI pictures. This is an advanced 3D imaging device (MRI stands for 'Magnetic Resonance Imaging') that allows the observer to read an accumulated, computerised picture package representing an 'ill' organ of a patient from different angles at his own pace. It is important to note that the carrier's contents do not move (the contents are literally saved), while the MRI can move through this still picture information like a fish swimming in the water. He rotates, fragments, intersects, tomographs and analyses the desired pictures as long as he deems necessary.

3.5 'PLAQUE FIXE' VERSUS 'PLAQUE MOBILE'

In his book *Le Mouvement* (1894), Etienne-Jules Marey differentiates between two approaches for capturing moving pictures chronologically by means of the 'chronophotographic' method he invented: 'chronophotographie sur plaque fixe' and 'chronophotographie sur plaque mobile'. According to Marey, the first method is possible through the of still (non-moving) photographic plates onto which the information, a series of photographs, is stored simultaneously. The sum of the stored result is a structured meta-image that needs to be 'read' as a whole. The way of looking at this kind of carrier is therefore analytical, because the observer moves, while the carrier and the image remain still.

'Chronophotographie sur plaque mobile', on the other hand, is about a time-based carrier that moves, while the observer does not; this is the fundamental difference between plate-like disk and string-like tape. A tape means that the information is successively, or chronologically, segmented into small portions of an equal amount of independent pictures. Reading those images is

therefore carried out in a serial — usually chronological — fashion. The latter is usually true, because each picture has a fixed place on this moving carrier. If the sequence of images is 'played back' in the same direction, this projection method is clearly the predecessor of moving pictures as we now them.

The 'plaque mobile' principle encouraged Marey to start working on several instrumentations in the 1880's. Some of them were hybrids between plate and tape with equally hybrid features. One of the first models was the 'plaque tournante' — a rotating photosensitive disk loaded into a kind of 'photo gun': the 'fusil photographique'. This instrument was first presented and developed by the French astrophysicist and colleague of Marey's, Pierre Jules Janssen (1824–1907), but has since been forgotten. The only model still around today is the predecessor of film as we know it: the so-called 'pellicule sensible', a photosensitive tape, nine centimetres wide, that allowed for recording a large number of photographic pictures as a series. Marey called such tapes with picture series 'simili-gravure'.

The chiefly social relevance of these tape media only becomes apparent when the pictures are projected onto a film screen in rapid, but constant, succession and, of course, in chronological order. This is the most fundamental way of showing movements in an artificial way to an observer who does not move. This projection method transforms the still observer into a passive consumer and the film screen into an obscure voyeuristic hole.

As long as the film pictures roll along the projection lens at the same speed as during the shooting, we can rest assured to be watching a faithful reproduction of the images. For the reproduction of reality, matching the recording and playback speeds is of utmost importance. In the arts, on the other hand, there are completely different intentions at work, and faithful reflections of reality certainly are not among them. The arts ignore single-speed, 'faithful' picture transport: the director shifts the picture carrier into all imaginable positions, and also works with varying speeds. He 'composes' his images via tape editing, video manipulations, and cutting and splicing. By constantly changing the viewing angles, he creates new, moving, film-artistic realities and spaces. The virtual video artist, finally, completes this evolution by

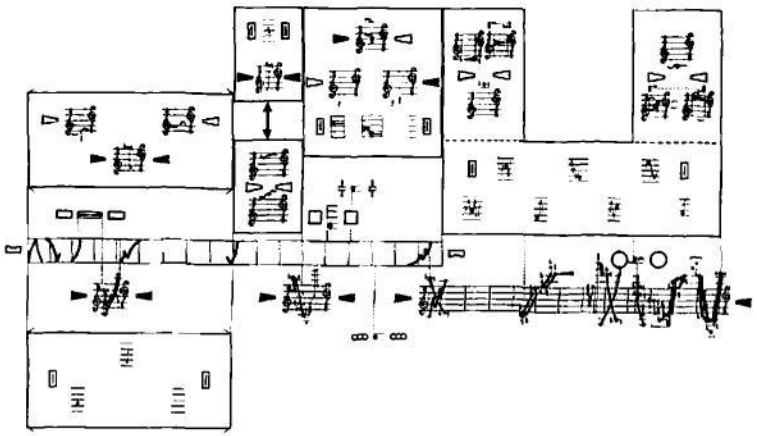
expanding the angled screen to a frameless world, where pictures can move based on all kinds of imaginable and imaginary (virtual) co-ordinates.

By extending this representation, a possible future kind of film art might very well cease to put photographs in motion and instead show three-dimensional holographic pictures that 'breathe'. In the light of such a future evolution, film as we know it merely means that a still, fixed 'spotlight' is being used: literally a light point (no matter how plane- and image-shaped it may be) whose lightness, colour and shape change all the time. In the future, however, we will no longer want to look at a point but at complete, multidimensional spaces, or their simulated artificial versions, where pictures no longer dash from left to right on a screen, as is the case now, but 'breathe' in a fixed position. This would be a 'mix' of photographs, film and holographic reality. That, in a nutshell, what the future might bring.

3.6 HARD DISK

Writing a series of consecutive stages of movements onto 'plaque fixe' results in a photographic plate that contains a number of similar pictures that are 'tomographic bits of reality' and as such layered and juxtaposed. Such layered pictures are presented to the observer as a complete unit, an 'aggregate'. If such aggregates are read from a tilted angle (something that can be programmed at the time of taking the pictures), the act of reading them results in an observation of a kind of 'virtual curve' for viewing the recorded movement. This process does not really show the movement itself, but rather its 'contour'.

With his 'plaque fixe', Marey was one hundred years ahead of computer hard disks, which is remarkable to say the least, especially in the light of the terms used for both devices: 'plaque fixe' and 'hard disk'. But not only that. An even more important correspondence is that both kinds of 'plates' do not really move themselves but rather invite the user to move by reading the plates at his own pace. It is not the plate that takes care of the story, it is the user; the plate doesn't tell us anything, the user 'reads' it. (Note. One could say that a hard disk moves inside the computer's enclosure, which is correct, of course. But the disk's rotation is

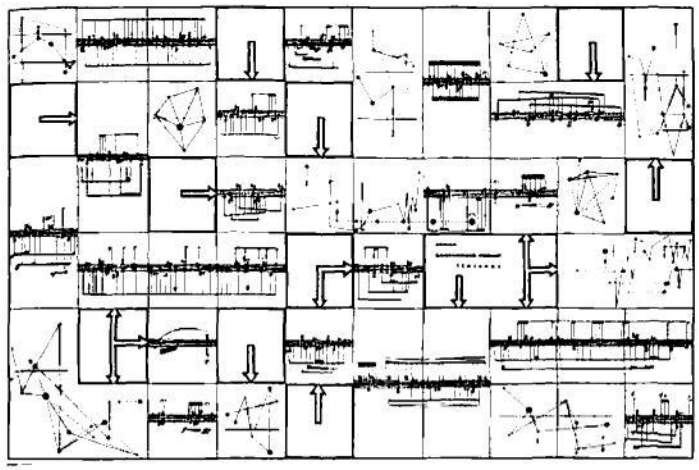


Ill. 10
Board-shaped score: Zyklus für einen Schlagzeuger *(1959). Karlheinz Stockhausen.*

only the condition for allowing the user to read it at his own free will and pace.)

A central question in all this is when and by whom the operative factor is brought about: by the programmer who writes information on the plate at his own pace, or by the active user who studies the plates at his own pace? There are two time factor at play that do not correspond to each other and even need not do so. Writing a programme indeed demands another kind of time than using that programme. (This situation is quite unlike the one during the production of a movie and watching it, because there, the illusion of synchronisation and synchronicity of the actors' movement and the movie goers' act of following it are both the starting point and the goal.) [3.4]

Despite the 'plaque fixe's' above qualities, the 'plaque mobile' has by far outlived it when it comes to practical and social applicability. The fact that this moving carrier eventually evolved into film technology as we know it, is probably the most convincing proof of this. Given this evolution, the 'plaque fixe' came in second, so that we can safely say that Marey's plate was forgotten from an



Ill. 11
Idem, Liaisons *(1959) Roman Haubenstock-Ramati*

evolutionary point of view. Until now, because the essence of the 'plaque fixe' and — even more so — the way of using it seems to specifically correspond to the way computer hard disks work and how we use them. It looks as though the essence of Marey's 'method' is about to make a comeback in modern architecture, music, and science. We shall come back to this later. Let us first discuss a number of significant, content-related parallels with this 'forgotten disk' and make a few bold associations.

3.7 THE 'PLAQUE FIXE-MODEL' AND SERIALISM

The sequence in which pictures of a film tape are played back is called, chronological, 'serial', and 'en file'. Using the term 'serial' leads to an interesting problem. By its very nature, the serial belongs to the realm of epic storytelling. Just think of serial comics with is series of pictures, or of the *Bayeux tapestry*, one of the earliest examples of this genre. Epic storytelling is clearly hierarchical and therefore has a beginning and an end; the beginning exposes the drama, while the end shows the dénouement.

Serial composition as it was applied and developed in the 1950's

and 60's, however, serves an altogether different purpose. This technique is indeed 'un-hierarchical' to the bone and therefore completely at odds with the linear story line: it establishes the equality of a number of fundamental musical variables. Such serial music wants to build fields rather than rows, it does not look for stories but walks. To this end, it uses an 'open form', a circular setting, the group technique, electro-instrumental rather than guided improvisations to be performed by nomad-like ensembles.

In that respect, Marey's 'plaque fixe' shows an unexpected likeness with the plate shape of the graphic scores used in the 1950's and 60's. Some of those scores were extremely loose-leaf and had a thorough page layout consisting of various sections. Others looked like foldable board games — real cardboard plaques covered with graphic symbols you did not read but 'play' based on the rules of the game, which required interpreting them. In short: while film tape represents an animated movement where the observer plays a passive part, the field-shaped plate represents an open-form setting of an optimum 'open' society where the same observer plays a democratic part by actively participating in the act of observing.

3.8 KAREL GOEYVAERTS' 'PLAQUE FIXE MODEL'

Following the analysis of the principle of diagonal sound in chapter 2, where the way in which the Belgian avant- garde composer Karel Goeyvaerts created sound layers was introduced [2.1–2.3], this time to analyse the carrier of such a stack. Let us therefore look at a notion Goeyvaerts introduced in 1952 for committing 'dead sounds' to a non-moving carrier — a kind of immaterial, virtual, still memory. Goeyvaerts clearly did not think of playing back this non-existent carrier from start to finish (because there would have been nothing to play back); using our terminology, one could say that he was thinking of a kind of ideal 'acoustic plaque fixe'. This plate was to contain the crystalline tone structures whose intersections represented locations of dead tones. The listener was to move in order to grasp the internal relationship of these tones. To this end, he had to move around those tone structures so to speak, like a mineralogist moves around crystals. (We have already encountered this way of moving about as a kind of walk through sound fields and matrix systems while dealing with

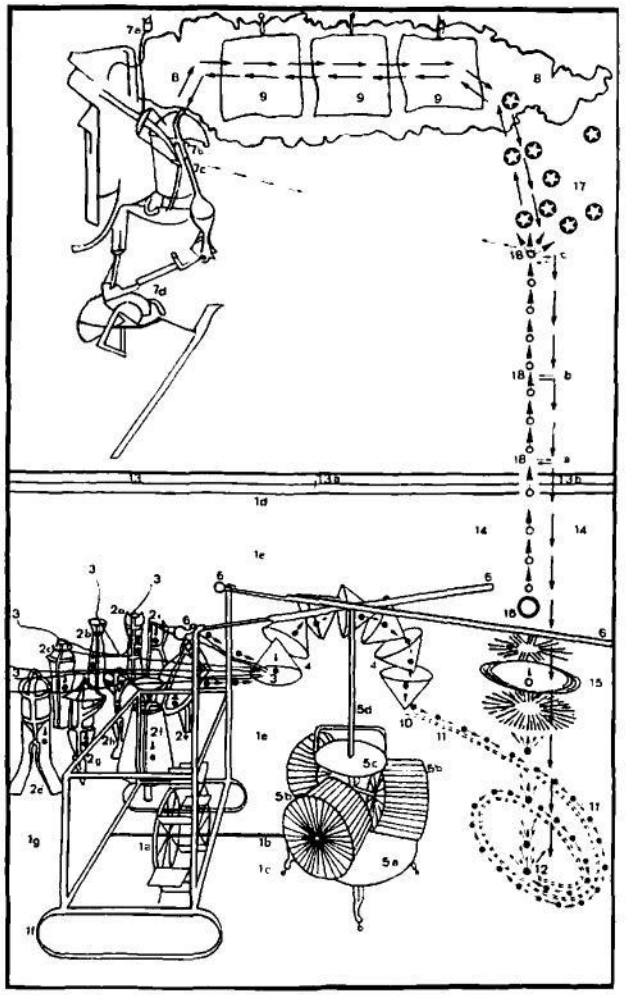
walks through fixed structures. [2.10–2.11])

Given that such an idealised concept of moving about and walking cannot readily be put into practice, Goeyvaerts imitated these movements and made a chronological (sic!) report of that was committed to magnetic tape. This report, the tape, was the actual composition which he chose to call *Kompositie Nr. 5* in this particular case, or simply *K5*.

Similar to the way in which an acoustic plaque can be read in Goeyvaerts' case, a picture sequence written to a 'plaque fixe' by Marey can be considered a report of a walk around the object to be registered. It is then safe to say that Marey carried out this walk on our behalf and recorded the report to a photographic plate. An imaginary, ideal, 'plaque fixe' would allow one to make as many reports as there are walks. The total package of these reports is a kind of 'holographic' super-image of the original moving object [2.8]. That is how one could consider the total number of reading walks of one of Goeyvaerts' plates to be the resulting, mainly holophonic, composition. Though unlikely from a practical point of view, it appears conceptually possible.

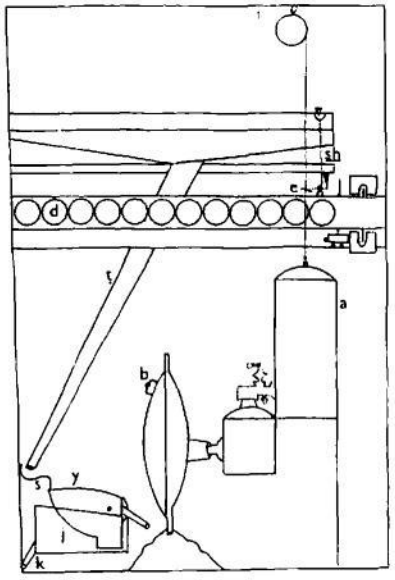
3.9 MARCEL DUCHAMP'S 'PLAQUE FIXE MODEL'

A slightly interpreted parallel with the basic concepts of the 'plaque fixe' is Marcel Duchamp's (1887–1968) idea of unrepresentable 4D structures to be projected into representable 3D environments where they can be 'read'. For the representation of this idea, Duchamp introduced such notions as the walking eye, the 2D eye, tactile observation, exploration by touching and a 4D continuum that needs to be walked through, read and represented in a 3D continuum. Duchamp's ideas were not at all concerned with a chronological report of an observation (a story, comic, film); he wanted to trigger a new kind of observation act for the viewer. This new way of watching can, for the time being, only be interpreted in artistic terms; scientific terms do not allow us to so, with the exception perhaps of sociological attitudes and behaviours. Duchamp nevertheless saw the importance of expressing his ideas using scientific terms. (Here again, we are dealing with showing something in dimensions — scientific ones — different from those where the original is located , namely art.)



Ill. 12
Marcel Duchamp: Large Glass, *1914–1923 (in a sketch by Jean Suquet)*

Between 1914 and 1923 Duchamp developed his 'Large Glass': *La mariée, mise à nu par ses célibataires, même*. This led to a perfect example of graphically projected and layered representations of



Ill. 13
Al-Jazari, hydraulic watch construction, 13th century. An interesting comparison: as a flat image, the drawing of Large Glass, *by virtue of its function (that of a transforming machine) corresponds amazingly to the operating instructions of the medieval Arabic engineer Al-Jazari. His drawing, too, cannot just be read—it needs be studied and interpreted. There is no trace of depth, just flatness and height.*

technical constructions and relative systems within the framework of a single, unique work of art. With this work, Duchamp created the necessary conditions for a new way of observing and interpreting. *Large Glass*, by virtue of its concept and principle as an 'automated device', is a gigantic 'large plane' that allows for multiple interpretations and that can be read and interpreted in a timeless fashion.

Such a way of representation did not come out of the blue. Around 1915, a graphic image reproduction of machines, apparatuses and technical constructions was added to the usual two- and three-dimensional representations of such devices. An approach mainly brought about by artists, it led to detailed drawings and

collages of networks, circuits and so-called flowcharts, whereby archetypal basic components were symbolised in a very individual, sometimes metaphoric, then again dadaist, but always poetic way (Francis Picabia, Moholy Nagy, Bauhaus members et al.). The intention clearly was not to give a faithful reproduction of the external instrumentation of those machines but rather to find a clear way of presenting the underlying, hidden links, connections and interaction of their components.

3.10 THE 'PLAQUE FIXE MODEL' AND THE FOURTH DIMENSION

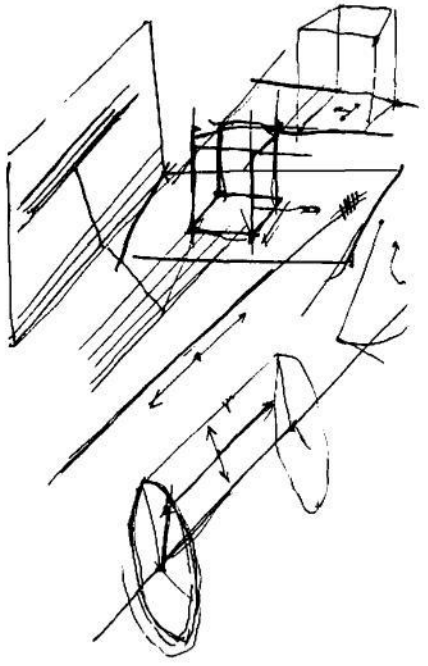
Duchamp's way of representing things is connected to two aspects whose relevance for this paper — reading and perceiving assembled picture aggregates — is such that we need to look at them here. The first is about graphic transfers of pictures from one dimension to another. This question was already raised while looking into the projection of sound matrices [2.8]. It is however, worthwhile to return to this projection on Marcel Duchamp's terms, because *Large Glass*, as a layered image, can be considered a typical representative of the 'plaque fixe'.

Providing pictures of three-dimensional objects in a workable way is usually based on a projection from different viewing angles onto the same flat plane (technical drawing). By layering these projections, as it were, we can compare them and reduce them to one single resulting image. Transforming 3D objects into 2D planes involves sacrificing one dimension, usually the one of depth, and replacing it with a diagonal line. True to this approach, Duchamp, in *Large Glass*, built three-dimensional graphic figures that he considered projections of four-dimensional realities impossible to represent directly and beyond perception. To reinforce the impression of four-dimensionality, Duchamp recorded the whole thing to a transparent medium you can look through: glass. The glass 'carries' the projections, whereby the carrier itself, save for a number of cracks, is supposed to express the missing elements of these projections.

Thanks to its application, *Large Glass* is not just transparent but also wide in the sense of boundless, even though is resides in a square frame where spatial constructions 'that work' appear. Yet we

do not look head-on at such a construction that works: we see through it. The depth of *Large Glass* as a work of art is therefore unfathomable and hence an illusion. *Large Glass* is also flat, however. It can be read by us in its capacity of 'plaque fixe' when positioned vertically, even though we may not readily understand what we read.

Due to the impossibility of presenting four-dimensional realities and the possibility of doing so (because we are dealing with art), *Large Glass* is shrouded in a 'cloud of initial stages'. The work can but be understood, seen and read based on the supplied explanations, interpretations, exegeses, diagrams, and tables, but also with well-calibrated illusions, a little poetry and humour.



Ill. 14
Marcel Duchamp, schematic representation of pluri-dimensionality, the so-called White box *('Witte Doos', 1911–23)*

3.11 THE 'PLAQUE FIXE MODEL' AND LANGUAGE

The second case is about adding linguistic signs, such as letters, numbers and symbols to works of art, so that the latter must not just be looked at but also read. For the first time in art history, these additions served the purpose of conveying intentions and forces: invisible movements that are quite common in mechanical and electric constructions. Including linguistic signs in paintings therefore meant that the work of art came with instructions; quite a novelty in the art scene in those days! (It is interesting to confront this phenomenon with the way in which certain household board games comes wit symbols, lines numbers, arrows and — more importantly — various colours: two-dimensional graphic 'worlds' where we used to fight full-blown battles with our families. This correspondence is not only striking, it is also meaningful.)

One of the most basic linguistic signs that can be used in a painting is an arrow. At first, the presence of such an arrow seems to contradict the observer's freedom of finding his own way of looking at such pictures and his own interpretation. The mere presence of an arrow therefore turns this freedom into irony. Duchamp, in his picture *Moulin à Café* (1911) was the first to use the arrow. It was used to indicate the crank of the coffee grinder by means of a rounded arrow, while the crank had itself been verticalised in an 'egyptonomic' way. ("... The simple fact of drawing that arrow, out of a hunch, proved a great satisfaction for me ...", is what Duchamp later said.) In this painting, the arrow indicates a mechanic rotation movement; in subsequent works, as in works by Francis Picabia, Moholy Nagy and others, such arrows represent invisible, sometimes electric currents rather than a mechanistic movement.

3.12 THE 'PLAQUE FIXE MODEL' VERSUS PIERRE BOULEZ' HORIZONTAL ARPEGGIO

We are now closing in on the most fundamental ways of expressing the 'plaque fixe model', i.e. the 'horizontal arpeggio' by Pierre Boulez already mentioned under [2.1] and [3.1]. This principle is part of a morphological understanding of spatialising sound,

Ill. 15
Marcel Duchamp: Moulin à Café *(1911)*

Ill. 16
Moholy Nagy: Kinetisch-konstruktives System *(1922)*

which Boulez first put into practice in his 'magnum opus' *'Répons'*. In his idea of horizontal arpeggios, pre-determined 'mother sounds' (short instrumental figurations) are distributed in time, and hence horizontally, as series of rhythmic replicas of those mother sounds, thanks to electro-acoustic tools (microphones, samplers and real-time computers): the mother at the onset and the replicas as waving tails behind it. The correspondence with Marey's way of spreading several uniform photographic pictures on the surface of a fixed plate is remarkable. Boulez does the same, this time, however with uniform electronified sound pictures distributed in space. In fact, both have the same intention: expanding and multiplying visual and aural mother images respectively to complex 'image aggregates'. The underlying understanding is that emancipated observers, led by their analytical attitude and based on clever strategies, will take the initiative to 'read' these aggregates in their own way.

Note. The term 'horizontal' is unknown in regular music practice. Strictly speaking, the terms 'arpeggio' and 'horizontal' indeed refer to the same concept: horizontalising a number of vertically stacked tones in the guise of a chord or harmony. Executing an arpeggio literally implies that the vertical is being horizontalised. If there is indeed a difference between vertical and horizontal arpeggios, it can only be related to the speed at which the notes follow on another. In this respect, it would be useful to provide a new context for the 'horizontal arpeggio' concept and to explain its meaning in more detail.

3.13 A MORPHOLOGICAL CONFLICT

In the above, the mother sounds were already mentioned. These are smeared out in space in a horizontal, time-line direction by means of electro-acoustic tools and thus rely on series of rhythmic replicas. These replicas are not entirely identical with the mother sounds, their shape and quality change as time goes by. The sum of all this, from head to tail, is a structured, multi-layered sound that is not injected into the hall via four or more discrete reproduction points, as usual, but rather via dense speaker chains — another predecessor of the dream of future holophonic reproduction techniques based on a pluri-dimensional diffusion of sound in space. This reproduction treats space as a compositional entity

rather than a topographic-architectural fact. The structure of a horizontal arpeggio and that of the repetition of replicas come together and overlap. This leads to the realisation of an impressive ideal: space is no longer filled with sound in an obscure way, its spatial nature is being composed!

Unfortunately, Boulez' main premise for this endeavour proves questionable. He treats sounding sounds as though they were notes on a score. Sounds, however, are physical entities rather than linguistic symbols. Musical notes can be manipulated in the same way as mathematical signs and logical elements. That is precisely what you cannot do with sounds. The consequence of this statement is that numeric symbols can be added to and subtracted from one another, while sounds cannot. You can only sum them like apples and pears. 'Instrumentation' is what the art of adding up sounds is called; it is not, however, capable of subtracting sound, or of creating such a thing as 'anti-sound', not even when this is done by means of sophisticated electronic techniques.

There is no way around the obscure acoustic fact that sound can only be repeated but not answered. It is therefore all the more striking that Boulez — both from practical and conceptual point of view — ignored the fundamental difference between sound as a physical phenomenon and sound as a linguistic symbol. The inescapable consequence of this was that the revolution he promised, real-time sound manipulation, went nowhere.

3.14 MORPHOLOGY VERSUS COLOURISM

The above statement appears even more correct when you look at another live-electronic work by Boulez, ... *explosante-fixe* ... (*Exploding-Fixed*, for three flute solos, instrumental ensemble, and computer electronics, 1994). There, he simply tried to avoid the problem of question and answer by using a lot of imagination and masquerade. Unlike *Répons*, the sounds of ... *explosante-fixe* ... are not generated on-site, that is, in the concert hall, but derived from 'explosive' sound expansions and alterations he recorded in his computer studio. This resulted in multiple transformed flute sounds to an extent that they remind you of percussion, glockenspiel, strings, piano, synthesizer, and voices. To achieve the intended effect, all kinds of blowing techniques, such as

'Flatterzunge', pizzicato effects, lid rattling, and blown 'multiphonics' were expanded to the extreme using sophisticated electronic studio techniques. Based on a specially developed score, these results were then used in all possible combinations and given new dynamic 'overall curves'. Only after performing this total 'transfiguration' could the flute sounds leave the studio in groups and be 'released' into the hall during the performance by means of commands. (By means of commands! One of the three flutes was indeed connected to a kind of 'information counter' of the computerised sample gear and peripheral memories. The flute player therefore had the possibility to recall and reproduce the stored sound configurations at his own free will.)

The significance of this ... *explosante-fixe* ... approach is linked to the fact that, unlike in *Répons*, the performed sounds were neither modified nor sounded in real-time but only recalled as command signals. Each signal indicated the moment when a given group of tweaked flute sounds was allowed to enter free space. Performed sound thus became a push-of-a-button phenomenon rather than a physically sounding object.

With this approach, Boulez tried to achieve what he called a 'decolonization of sound'; a literal crossing of boundaries and transcendence of musical instruments (the flute in this particular case). In fact, Boulez merely returned to a long-abandoned area of colouristic sound exploration, even though this step seems to be justifiable given the use of highly advanced electronic devices in ... *explosante-fixe* ... That doesn't mean that his case is lost altogether: it is a case based on a method that is being revived in a regressive and hence questionable manner, no matter how 'ear-blindingly' beautiful his composition may be.

3.15 A SECOND MORPHOLOGICAL CONFLICT

Let us return to Boulez' *Répons* which was created about 13 years before ... *explosante-fixe* ... It contains a second problem that is closely linked to the one mentioned above [3.14]. Put simply, it boils down to the fact that multiplying instrumental sounds via speakers in a concert hall must invariably lead to sky-high stacks of sound mass surrounded by huge blocks of hardly discernible 'horizontal arpeggios' of sound strings. (Or, as Boulez puts it somewhat euphemistically, by "arpeggios of arpeggios".) When applied rigidly, this procedure leads to a sound that grows all the time but cannot shed anything. Such an overproduction and accumulation of sound is not only undesirable from a musical-environmental point of view but also increases the danger of 'acoustic arrests'.

The title 'Répons' is significant for this problem. The name 'Répons' is derived from the medieval 'responsorium': an antiphonal alternation between an individual and a community. The title *Répons* expresses the desire to have instrumental 'question-sounds' interact live with computerised 'answer-sounds'. The questioning live sounds are the individual, while the answering computer sounds are the community. Unfortunately, as stated above, sounding sounds cannot ask questions, nor indeed answer them, because they lack linguistic logic. They are physical entities that can only be repeated. (Unless one uses a written score as go-between, where the game of questions and answers can be simulated and staged in minute detail; or by adding lyrics to the sounds. But that would be language again.)

3.16 DISK VERSUS TAPE

A certain parallel between Boulez' arpeggio sound and Marey's layered image is not related to their external shape, but to the way in which sound and image are 'instrumentalised'. While Marey carefully distributes the repetitive images as a fan — a visualised 'horizontal arpeggio' — across the surface of his 'plaque fixe', Boulez 'composes' repetition structures that allow him to distribute sound images in a horizontal direction throughout space with the same attention to detail. Marey and Boulez are in fact looking for the same thing. Neither researcher is worried about chronologically structured series of pictures or sounds. They both want to instrumentalise systems of warped continuums; picture structures extended across fields (Marey) and space (Boulez); territories of juxtaposed pictures and sounds in which the observer can dwell and travel at his own pace.

Even though Marey had no doubt about the value of his morphological analysis of movement and the related registration method, there was a crucial stage during his analysis when he ran

into sensitive photographic tape — the linear 'pellicule sensible'. From that moment he felt more or less the urge to favour the extremely seductive time-based carrier over the timeless, conceptual 'plaque fixe'. Boulez, on the other hand, at a comparable and equally crucial stage, rejected string-shaped magnetic tape, opting instead for field-shaped computer hard disks. That is where Marey and Boulez parted company forever, while this split showed a fundamental hierarchical opposition that, as far as Marey is concerned, was only bridged almost one hundred years later. Only then was it indeed possible to subject time-based filmic structures, that are usually committed to 'pellicules sensibles', to computerised manipulations, thus liberating them from their strictly linearly-fixed appearance. Totally new artforms, such as 'video-art', 'computer-art', 'image simulation', 'virtual reality' and so on, were the direct consequence of this evolution.

3.17 SCIENCE AND ART

It strikes one as remarkable that both French pioneers set up official institutes for scientific research into image and sound shaping respectively in a collective context. In 1880, Marey set up his 'Station Physiologique' at the very place where the Rolland Garros tennis courts are today, while almost a century later, Boulez founded the IRCAM — 'Institut de Recherche et de Coördination Acoustique et Musique' — in downtown Paris. From the point of view of work atmosphere, staffing, laboratory set-up, guest researchers, and semi-public demonstrations, the degree of similarity between these two institutes is amazing. The presentation of their products, however, exhibits an interesting contradiction that, far from being anecdotal, has fundamental roots.

While Marey conducted his research as a scientist, Boulez approached his scientific exercises from music. While in Marey's publications the artistic dimension of photographic pictures constitutes a side issue — the splendour and beauty are clearly at the service of science —, Boulez sees the presentation of the artistic as the dominant factor, whereas the scientific aspect is usually at the service of the artistic. Now there is a fundamental and almost unbridgeable divide between practising art and technology. It is, in fact, a contradiction that is gradually being resolved today, even

though this initiative does not come from electronic and computerised music as advocated by Boulez' IRCAM in the early days, but rather by a largely internationalised world of 'electronified architecture'.

This discipline indeed continues where music has left off and, by doing so, turned its back on its most important task: composing space and sound in such a way as to lift both units above the trivial. While the bulk of present-day music practice is heading for the level of purely 'horizontal entertainment', the modern architectural scene is dominated by conceptual activity that can compete with the best elements of the musical spirit in the 1960's: the desire to devise an entirely new future for music; not a dream or quasi-spiritual but real, not compulsive but playful, not free from worries but very responsible and precise from a social and sociological point of view. Given that contemporary music falls short of quenching this thirst by all standards, it misses the chance of transcending the dimensions of everyday music consumption through a new pluri-dimensional and multi-layered open form.

There is absolutely nothing that seems to hint at such a pluridisciplinary and multicultural kind of music. Or, to put it as a paraphrase: modern-day society seems to have rejected the vertical aspect, as in 'depth', and to favour and encourage the horizontal, as in 'superficial'. Only in present-day architecture are there elements from the drive the music scene exhibited in the 1960's during its quest for a new morphology of matter and space. That is precisely why the last chapter, 'Spatial Sound', will provide ample textual and visual examples of that architectural branch and hint at a possible connection for future music.

4.
SPATIAL SOUND
From The Smallest Sound To Liquid Form

4.1 REPETITION AS A MORPHOLOGICAL CONCEPT

The central motif of this paper is that of finding a morphology of electric sound. Form the above, it becomes clear that one can only talk about true morphology when the vertical depth structure of sound exhibits a logical correspondence with its horizontal time structure. The following deals with the significance and consequences of this criterion.

Vertical depth structure is linked to the structure of the repetition plan in the repeater's mind. This plan not only comprises the number of times a repetition is to be carried out but also the extent to which the individual layers will be shifted — translated — during each repetition.

When used to refer to sound as a time-based phenomenon, the word 'repetition' implies that a sound can but be repeated when it has 'passed' in a temporal sense. When talking about layers, shifts, and translations, however, we do not mean chains but rather towers of sound that loom about. Here again, temporal and plastic representations appear to mix, which means that both are needed for coming to grips with the subject of this paper — the morphology of sound [2.8]. A serious morphological determination of sound is only possible when one is constantly reminded of the divide and its inherent terminological contradiction.

One could say that the 'stacker' is always aware of this divide while structuring the repetition plan! He is indeed the one who best understands that sound only materialises once you consider repeating and layering it a musical act. It therefore comes as no surprise that he will do everything he can to make his plan match both the repetition object (the sound to be repeated) and the repetition act (layering sound) in the most logical and acceptable way possible. The following elementanry example should clarify the 'logical' dimension of this relationship.

When multiplying the number 2 with 4, the numeric structure

of the operand '4' is of the same type as that of the numeric object, '2', to be repeated. (They are not equal by their function but by their structure.) Both numbers are symbols and can be exchanged without affecting the result of this operation, the number '8'. The repetition that is at work behind this result therefore only becomes visible when one takes one step back and writes down '8' as '2 x 4' or '4 x 2'.

It seems so simple, yet the same logical operation for repeating, and thus multiplying, sound immediately causes problems that are due to the incongruence of these two structures: the sound structure with its analogue and qualitative nature, and the repetition structure that is numeric, or digital. For instance: multiplying a sound four times with itself involves using two totally different structures, which is impossible from a logical point of view. (Note that this seems perfectly possible at the local greengrocer's, where four apples can be weighed in the same way as four pears. There, apples are literally compared with pears. Yet even the greengrocer needs to transform these unlikely relationships into unequivocal monetary values at night in order to record the results of his transactions in his books in an unequivocal way.)

4.2 REPETITION IN GENERAL

Before going any further, it is a good idea to note that most structures we encounter in our environment can in fact be reduced to time-based or plastic repetitions. Morphology indeed refers to the way in which a given fundamental formula — a primary body, the initial pattern, the mother of all cells — is repeated. Consider nature with its plastic organisation of cells into both inorganic crystals and organic tissues. Even the way in which musical instruments, for instance, cause the air to vibrate, thus producing multiple time-based organisations of vibration patterns, cannot be understood without being aware of the underlying 'vibration pattern'.

In a more educational sense, the 'repetition' subject can be expanded to 'repeating' in the sense of imitating, showing, educating, training, while, from a musical point of view, one may think in terms of several kinds of contrapuntal, canonic, fugue-like, and repetitive techniques. One could even go so far as to say

that this expansion stretches all the way to certain prevailing ideas in the arts (both graphic and musical) about authenticity, authorship, originality, sampling technology, collage techniques, and so on. Just think of Walter Benjamin's essay *The Work Of Art in the Age of Mechanical Reproduction* (1936). As far as authenticity and originality are concerned, you can also think of the early 15th-century Japanese Nôh dramatist Motokiyo Zeami who fundamentally developed the technique for learning off by heart texts, sounds, and movements by means of imitation and repetition.

In short: the 'repetition' subject has multiple facets and, far from being confined to technicalities, bears on social matters. The correct way of dealing with it hence lacks a certain linearity. This calls for a systematic approach in order to find a way through the polymorphous field of variants towards the repetition principle that lies at the heart of the morphology of sound and image, for that is what is called for here.

4.3 FOUR MORPHOLOGICAL AREAS

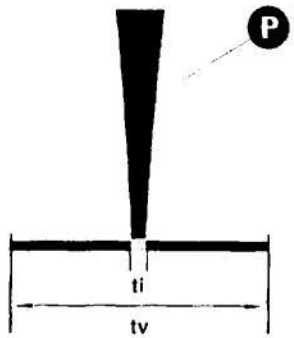
With a view to finding the aforesaid way through the field of repetition possibilities, let us look at several areas of the arts and science where morphological structuring of technical images, and thus also of sound, are applied from different angles. These four areas were already mentioned in the preceding chapters. Here, we shall look at how they relate to one another. The first area is about a systematic morphological method used for representing abstract electric sounds by means of sound matrices in a modelised way. This method was developed by myself in the 1960's so as to explain the relationship between the sound object, the treatment of sound and the sonic result. This method will here be presented step by step.

Next, we shall look into the principle of 'superposing' photographic images as practised by Etienne-Jules Marey in 1880 [3.5–3.6]. This principle will be compared with calculated repetitions of instrumental basic sounds which was first applied live by Pierre Boulez in his 1980 work *Répons* [3.13]. That is the third area. The fourth and last is about the way in which modern-day architecture uses compugraphic representations of trans-architectural volumes in the guise of so-called 'liquid forms'.

4.4 SOUND AS A POINT

Traditional music notation uses notes. Notes are symbols with an unequivocal point-shaped character. Such notes are supplemented with accidentals, other sorts of signs, and short explanatory words or letters. Though satisfactory, this notation system is not ideal. The ideal would be a coherent kind of music that is only represented by means of points, that only consists of points, and that comes about through operatively relating points with points. Such a music is basically comparable with classic counterpoint, i.e. the art of 'punctus contra punctum'. Put this way, the morphological method therefore focuses on the realisation of true 'contrapuntal' music.

In the morphology of electric sound as it is presented here, such points are visualised as pins — brief electric pulses — that are located on a time axis. The acoustic effect of such a pin is a dry tick. Such a tick indicates a short moment in time and has no other musical pretension whatsoever as long as it is heard. The pin balances between a concrete acoustic tick and an abstract point like a chalk dot on a blackboard that balances between a drawing and a sign.



Ill. 17
An electric pin (pulse) (P) of a given duration (ti) in a field (tv).

Each pin, no matter how small and point-shaped it may be, has a certain physical width that is determined by its time (ti) and electric tension required for rising from zero to plus and back to zero. Such a pin is surrounded by a field of silence (tv). The field and pin constitute the basic material that allows one to construct the 'initial composition' through repeating and layering it.

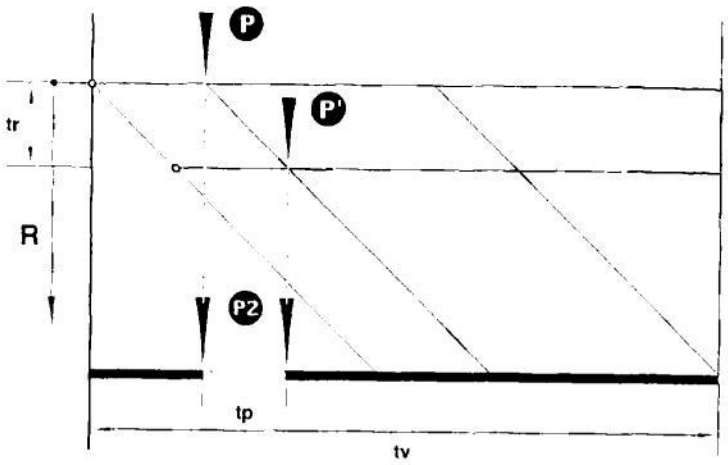
4.5 A SECOND POINT

Placing one single point is not enough for expressing something. At best, this would be a demonstration of a sound that does not sound and hence has an abstract quality. Such a sound is related to nothing because there is only what sounds. This situation changes when a second pin is added because that crates a relationship between these two needles that can be pinpointed both physically and musically.

The second pin does not appear 'randomly', by the way, it is the work of someone who has carefully chosen the exact position of the second pin with respect to the first one. Through this opposition of pins, this 'someone' proves to be a composer in the true sense of the term ('com-ponere', lat. = put together, arrange; here arranging pins). He is the creator of a fundamental and elementary 'sound atom' whose character is determined by the way in which this juxtaposition, or counterbalance, comes about.

By giving birth to a second pin, the composer does not create a second instance but rather a *repetition* of the first. This is quite unlike what you do when practising technology, plastic arts, or architecture. After all, this is a time- based manipulation rather than a plastic one.

The entire act of repeating starts with the instruction '*repeat!*' The sign this instruction represents is also a point, more specifically the *now!* point. A composer who repeats a pin confronts it with the point-shaped instruction *now!*. The needle and the point, in their capacity of signs, have the same quality. They are both abstract markers related to each other in an unequivocal way by the composer. The most fundamental criterion for a true morphology of sound, i.e. the likeness of the sound object (P) and the act of repeating it (R), can be said to have been met.



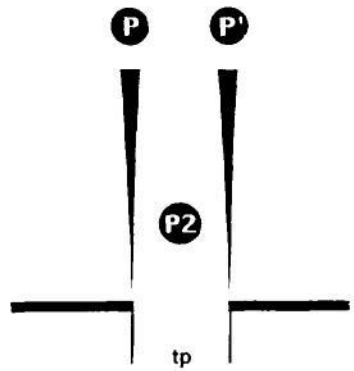
Ill. 18

Representation of a pin-shaped sound object (P) that is subjected to the act of repeating it (R) for a given repetition duration (tr). This act results in a 'composition' (P2) that consists of a double pulse of a given duration (tp).

4.6 WE, THE LISTENERS

The composer who repeats a pin acts as performer of his own repetition plan. To him, repeating means something like a dynamic, 'musical', act rather than a static automatism that he can build whenever he likes using a pen and paper. But there is also a 'we'! When the second pin appears in the world through a jump, we are witnesses of a short but nevertheless entirely compositional creation process. Not only are we confronted with the execution of a temporal repetition plan, we also witness its instrumental shaping. (Instrumental, because the second pin is added to the first by means of electric tools.)

Whenever the composer repeats a pin, we experience how that second pin blends with the first, thus producing an inseparable primary sound, a true primary composition whose nucleus consists of the most elementary pin pair. (During this process, we are completely unaware of this repetition plan, or the two individual pins. After all, we are only listeners, not the composers or analysts.)



Ill. 19

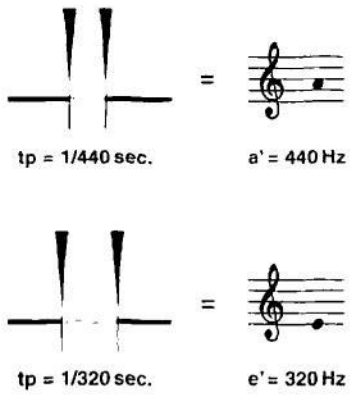
A primary composition (P2) of two pulses (P) and (P') produces a kind of acoustic 'actio in distans'.

4.7 PRINCIPLE

The repetition act serves the purpose of allowing the result of that repetition — the second pin — to relate to the original — the first pin. This relationship is established through the juxtaposition of these two pin. This juxtaposition provides a short-lived interference between these two pin: a kind of acoustic 'actio in distans'. The distance between the two pin is the determinant factor.

If the distance is small, the two pins appear as one to the ear and are therefore perceived as a single pulse. We are then dealing with a true 'sound atom' surrounded by a pitch gauze; a kind of tone lustre that does not exist in the real world but whose activity is perceived as a pitch sensation. In other words: we are confronted with the 'smallest possible sound' that can be imagined and performed both from a physical and musical point of view.

This smallest possible sound, or primary composition, with its imaginary pitch, is so short that its effect is already over before we have had the time to experience it properly. (For example: if the distance between these two pins amounts to $1/440^{th}$ second, we will hear a tiny 440Hz-tone particle during $1/440^{th}$ second, which is enough, however, to allow for an accurate perception of its pitch.)



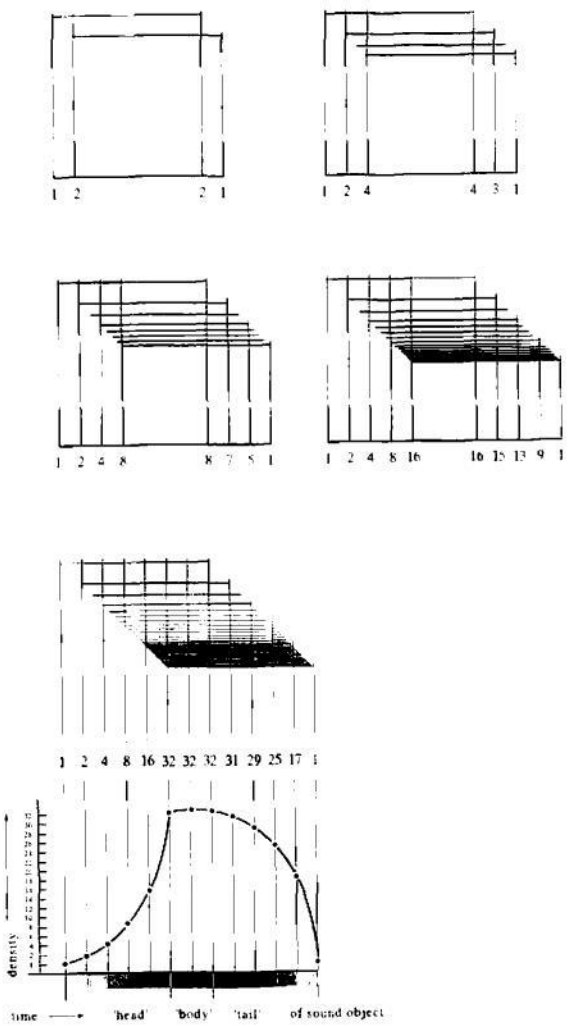
Ill. 20
A double pulse with a duration (tp) of 1/440th sec. sounds as an a', and a double pulse of 1/320th sec. as an e'.

When both pins are located further apart, we usually perceive them as a discrete rhythmic time interval. (If the distance equals 1/10th second, we hear two separate ticks.) A relatively large distance, finally leads to the pins being perceived as two separate ticks whose time interval marks a certain duration — a kind of clock time.

4.8 REPEATING REPETITIONS

Once the primary composition has sounded, the composer can decide to repeat it right away. To this end, he devise a repetition plan that will obviously be chosen with respect to the first. After all, he does not just repeat ad random, he works according to a plan. A second repetition act means that the composition will contain four pins. That second-generation composition can again be repeated, and so on. The total number of repetitions is the result of the execution of his composition plan.

Such a composition plan is aimed at combining all pin pairs, in their capacity of sound atoms, to molecular families. To this end, the composer start out by devising an effect repetition strategy for 2, 4, 6, 16... *n* repetitions of the primary composition at various distances. Let us agree to say that the composition is 'summed' with itself as many times as there are repetitions.



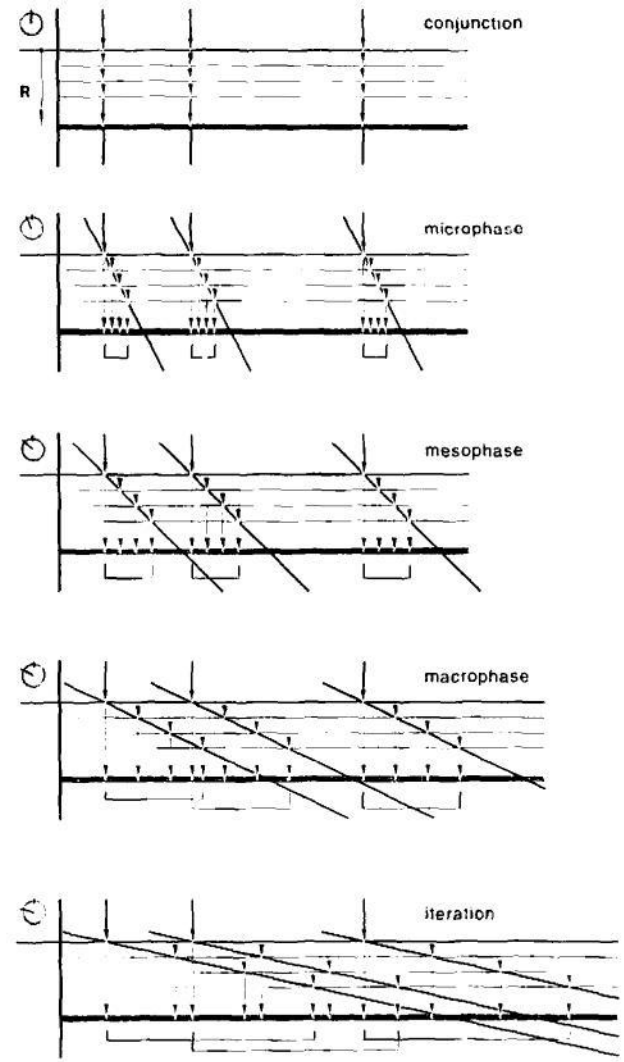
Ill. 21
Aggregate series of 2, 4, 8, 16, and 32 identical stacked sound layers. The layers are the result of successive repetitions of a given single sound layer, shifting these 'copies' with respect to one another, and adding up the result of this. The last aggregate clearly shows how this leads to the appearance of the phasis, trope, and dusis bands.

Adding up all repeating composition layers results in a sound with a head, a body, and a tail. From the point of view of contents and structure, these members correspond to the so-called 'phasis', 'tropè' and 'dusis' bands during the projection of tilted Mondrianic sound aggregates [2.10]. Layering, summing and projecting are terms that basically refer to the same, i.e. experiencing stacked uniform sound layers as a single unit. As stated above, a second stage could then be to use this single unit, a new 'primary composition', for new sums of itself. History then repeats itself as many times as the composer sees fit.

4.9 TRANSLATION

Repetition implies that the object of such a repetition is 'translated' in time with respect to itself. ('Translating' here refers to the shift of a given quality in a straight line with respect to other qualities. Such a shift contains a temporal moment that clearly applies to sonic art.) During such stacking and translation operations of sound layers, the original sound object and its repetitions overlap in roof tile fashion. Only in very rare cases do they sound one after the other, while in an equally exceptional case they will sound simultaneously.

Roughly speaking, the composer can choose from among five translation categories. The smallest translation refers to a 'microphase' shift that correspond to the distance at which the oscillation movements of tones follow one another, i.e. at about 1/16th- to 1/10.000th-second intervals. The second category refers to 'mesophase' shifts with 1/16th- to 2-second intervals. These are followed by 'macrophase' shifts with intervals of 2 seconds and more. Finally, there are also shifts whose repetition is only executed after the entire primary composition has sounded. This fourth shift category is a kind of 'iteration', which is in fact the most consistent and most frequently used kind of repetition. Then there is also the 'non-translation' category where the repetition is executed at the very moment when sound object to be repeated is sounded. We are dealing with a 'conjunction' that leads to a kind of 'acoustic eclipse'. The phase shift then amounts to zero seconds.



Ill. 22
Five translation categories: conjunction, microphase, mesophase, macrophase and iteration.

4.10 A NEW SPATIALITY

Fields and points, pins and pulses that result from the aforesaid translation categories can be compared with the result a rug weaver has in mind while weaving: the emergence of a multitude of patterns whose composition and repetition structures are revealed with every stitch and every fathom before our very eyes. The colour, shape and weaving structure merge into one. In the same way, time-based layers of points, pulses and pins create the sound fabric that are at the heart of controlled morphological music. Such music derives its plasticity not from moving passive sound bodies, as is customary, but from the synergy brought about when sound particles, or electric pulses in our case, are stacked and therefore engage in an interfering act.

The resulting sounds are not yet real, they only exist in a dream. Current loudspeaker systems, whose construction principles have not changed much since the 19th-century electromagnetic principles, are hopelessly inadequate when it comes to reproducing such neo-spatial sounds. We therefore need to wait for an as yet unimaginable 'holophonic' technology of a pluri-dimensional kind. Only then can current one-dimensional electronic sound generators be forgotten once and for all. In the meantime, we have to resort to models that obviously do not sound the same but are nevertheless capable of visualising and topicalising the conditions for such a way of sounding.

4.11 THE GRAPHIC METHOD

In [3.3] several graphic registration systems were mentioned, as was E.J. Marey's publication *La Méthode Graphique* (1878) where he introduced a number of methods for representing movements by means of graphic lines, usually by means of X-Y matrices. As his research was about movements of human beings, he built ingenious devices whose inputs were in one way or another connected to the moving parts of humans, animals, and even flying birds. The extremities of these devices were connected to moving pens that drew curves on the surface of rotating cylinders or translational tapes. In the 1880's, Marey expanded this tactile, pen-like, graphic method with radically new instrumentations of 'contact-free' registration practices, i.e. photographic ones. This allowed him to replace the rigid, sometimes unruly approach with a flexible, almost matterless variant that was to provide some sensational possibilities.

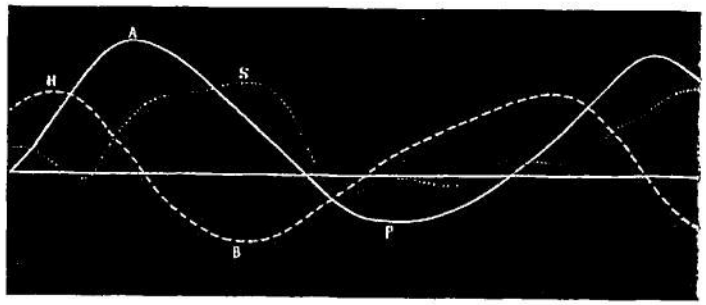
Let us briefly summarize the consequences of using this entirely new matter (see also [3.3–3.5]). Roughly speaking, there are two methods: one where the photosensitive carrier does not move during the registration, while its observer is actively moving, and the second where the carrier moves, while the observer assumes a passive attitude. The first category is inherently plate-, or rather field-shaped ('plaque fixe' and 'hard disk'), while the second is tape-shaped due to its narrative character ('plaque mobile', film tape, magnetic audio tape).

Another, equally interesting, difference is related to two utterly opposite ways of recording movements: on the one hand, the approach is 'analogue', whereby the contour of the movements is reproduced without interruption, while, on the other hand, it is 'repetitive' because the moving object is committed to the medium as a series of momentary pictures placed at equal distances. In both cases, there may be both analytical and synthetic objectives at play; analytical in the sense that the movements are to be subjected to scientific research at the observer's own pace, and synthetic in the sense that the recorded movements need to be brought to 'life' any time (cinematography).

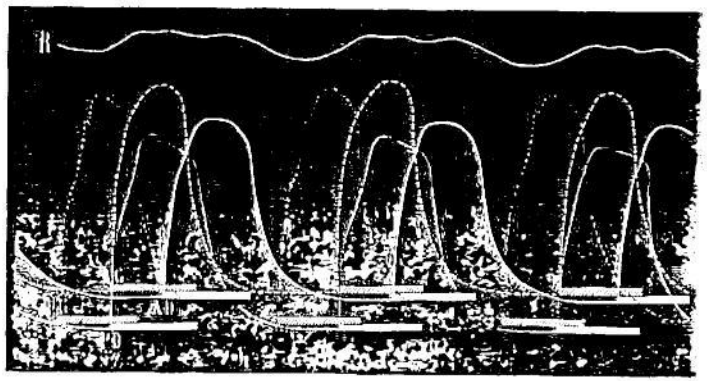
The ideal morphology of pictures appeared materialise only with layered, field-shaped pictures, not with its tape-shaped counterpart. Let us not cite a long series of cinematographic improvements and changes here and just look at the main elements for the relationship between these two, while ignoring all sidetracks, no matter how alluring they may appear to be. The bulk of the examples below are taken from Marey's work between 1875 and 1890.

4.12 THE X-Y MATRIX

A customary way of visualising movements is by recording a graphic figure within the framework of an X-Y matrix. The horizontal axis refers to time, while the vertical axis shows the changes of movements. Such a record may be a faithful reflection of the movements' contour, but it does not allow one to find out what



Ill. 23
Graphic diagram of the movements performed by a flying bird. The two curves in the X–Y matrix represent two levels of movement. The solid line represents the front-to-rear movements of the wings, while the dashed line represents the 'top-to-bottom movements. This method of graphic registration does not (yet) rely on photography: it is completely mechanic.
(E.J. Marey, La Machine Animale, *1873)*



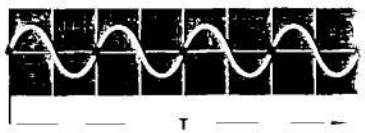
Ill. 24
Graphic diagram of a galloping horse. Compared with illustrations 31–34, this linear 'graphic method' clearly reveals the difference between the graphic and photographic method. The first translates movements by means of a graphic line in an X–Y field that only expresses one measurable value (e.g. up-down or front-rear), while the second starts out with what the photographic eye sees and tries to situate the variable character of certain movement components in spatial dimensions.
(E.J. Marey, La Machine Animale, *1873)*

lies behind the act of moving. It merely shows the result of a movement plan, the motives of which — the 'composition plan' — remain invisible to the researcher.

Records of rather more complex, but nevertheless cyclic, movements can usually be reduced to compositions of sine-shaped oscillation patterns. Complex patterns are recorded at regular intervals in seismography, medical research, traffic behaviour analysis, recordings of music (the groove of a gramophone record!), but also during physiological-kinetic research like that carried out by Marey. Consider the following two telling examples.

4.13 OSCILLATING MOVEMENTS

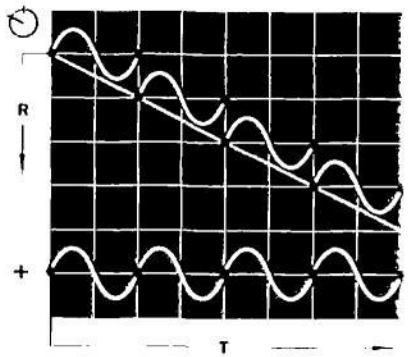
The most basic movement is no doubt that of a pendulum. When you record its movement, the result will be a sine- shaped graphic curve within the X-Y matrix whose horizontal direction represents the number of times (frequency), while the vertical axis refers to the momentum (amplitude) of the swings. The study of elementary oscillation patterns encounters the same problems as the analysis of more complex movements. While the external appearance of a sine wave can be visualised faithfully by means of the 'graphic method', the 'composition' of this primary pattern can only be guessed here. One question, for instance, is why the wave continues endlessly and why this basic pattern — the sine wave — is tirelessly repeated by its invisible mover. Another question is who or what might be this mover. Illustrations 25–27 deal with these questions more extensively.



Ill. 25
Graphic representation of a sine wave in an X–Y matrix.

This illustration provides an elementary, conventional representation of a sine pattern that is constantly repeated. Mind you, the

representation shows two things: the oscillations' image (that of a sine wave) and the number of times (four) this pattern is repeated. Both aspects lead to a 'snake-like' figure that exhibits four 'peaks' and four 'troughs' in the above example.

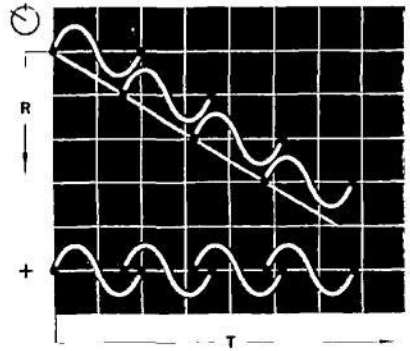


Ill. 26
Morphological representation of a sine wave.

This illustration shows the same sine wave as Ill. 25, this time, however, in combination with the repetition plan that lies at its heart. There are three units at play: the horizontal oscillation pattern (P) of a single 'swing', the vertical repetition plan (R), and the translation moment (T). The plan (R) indicates the number of times (four in the above example) the oscillation pattern (P) is repeated and the number of repetitions that can be summed in a vertical direction. This unit is combined with the translation value (T) that regulates the degree to which the (four) oscillation patterns (P1 – P4) are shifted with respect to one another during the addition. As always, the P structure is assigned the horizontal X axis. The R structure is assigned the vertical Y axis, while the T value lies on a diagonal line that crosses the P-R matrix. The sum of all oscillation patterns can be found on the so-called sum line, the result of which is the pattern (P.R.T).

In this example, the translation degree (T) is represented in such

a way that the sum line exhibits a number of oscillation patterns whose 'members' are connected seamlessly to one another. This is a kind of 'iteration' [4.9] of the horizontal oscillation pattern (P). As stated above, the external image of the resulting curve is completely the same as the sine wave in Ill. 25. Yet from the point of view of contents it is different, because the construction of the added matrix provides insight into the genesis — the underlying 'composition plan' — of this curve, which is totally absent from the first illustration (Ill. 25).



Ill. 27

Same as Ill. 26. Here, however, the degree of translation is smaller, so that the four distinct oscillation patterns are shifted in such a way that the resulting curve (PR) exhibits a cyclic but nevertheless complex pattern. (Coming to think of it, Ill. 26 could be considered a particular instance of a more general representation of the one shown in Ill. 27.) This leads to a 'weaving' pattern whose horizontal component is the equivalent of the vertical one, so that even this simple pattern has a truly morphological appearance. Showing the equivalence in both illustrations helps to understand why the morphological representation of movements is preferable to representing their resulting curves. The first encompasses the second, not the other way around.

4.14 A DESCENDING BIKER

Marey's 'chronophotographic' image (Ill. 28) shows an interesting parallel with the morphological representation of a complex sine wave (Ill. 26 and 27). Using photographic means, Marey recorded eight stages of a biker getting off his bicycle and committed the separate images to 'plaque fixe', thus layering them. The resulting image reminds one of a sine wave — not as a continuous line but proportionally.

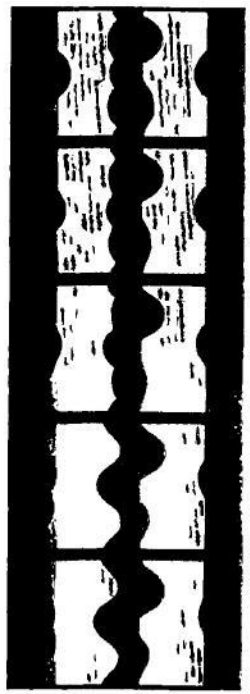
Ill. 28
E.J. Marey, descending biker in eight stages, 'chronophotographie sur plaque fixe' (1891)

Illustration 29 shows a morphological representation of the eightfold horizontal descending sequence of Ill. 28. To this end, the horizontal organisation (P) is made to correspond to the eightfold vertical addition structure (R). By doing so, the horizontal organisation is 'verticalised'. Yet that is not enough. The repetition and addition structure (R) as related to a series of bicycling images needs to be supplemented with a translation programme (T). Matching the dimensions and functions of these three factors, (P), (R), and (T) leads to the creation of 'weaving patterns' as a result of the addition of these figures whose horizontal and vertical layers can be considered equivalents from the a morphological point of view. As stated above, this matches the morphological structure of elementary sine waves (Ill. 26 and 27)

Ill. 29.
Two morphological organisations of Marey's horizontal descending sequences taken from Ill. 28.

4.15 AN APPARENT ANALOGY

A special image. On the one hand, it is composed of five discrete an separate film pictures of a film tape, whereby each film picture represents a stage of the swinging movement. On the other hand, the swing patterns seamlessly connect to one another, so that the film tape reminds one of a still 'plaque fixe' rather than a 'plaque mobile'. Note that the swinging movement was not recorded using photographic means but that it is based on a synthesis involving an animation of an engraving by means of a pen and ink. The point, however, is that an oscillation on tape refers to something different than the same movement on a plate.



Ill. 30
Walther Ruttmann (1887–1941), Opus-III *(1924), five pictures with an oscillation curve.*

4.16 TOO MUCH PICTURE

Repeated image layers of humans or animals in action — in Marey's case — quickly lead to image saturation. The observer can no longer see how the individual parts of those bodies move with respect to one another. Marey was aware of this problem, while there was also another problem. Marey was still alive when the speed of repetitive photographs dramatically increased. Even though this led to pictures of a much finer definition, the total package of the sheer number of overlapping pictures started exhibiting cobweb-like interferences, so that these stacks became proportionally unreadable. In short: there was not only too much image information but also too much 'meat'.

This phenomenon created a similar problem for Pierre Boulez' horizontal arpeggios when he was working on *Répons* in 1981. There too, the capacity of electronic devices to produce an overwhelming number of repetitions of living sounds led to too much sound and thus to a saturation of harp-like line webs.

At that point, around 1883, Marey took a crucial decision: he eliminated the chronophotographic registration of moving bodies by masking them with black cloth. Moreover, he painted white lines and points on arms, legs and all important pivot points, thus retaining only the most vital information. Get rid of all superfluous meat! — Only the bare skeleton counts! The intrinsic significance of this approach is that spatial physical 3D volumes of bodies were reduced to structures of abstract lines and points thanks to this graphic minimalism. They were 'digitised' as it were. Marey was therefore able to make abstract body structures correspond with the numeric repetition program with which the bodies were repeated and combined by themselves. (Because of its fundamental nature, this procedure has already been mentioned several times.)

Having implemented graphic lines and points in moving bodies, Marey was able to make over a hundred photographs, rather than ten, within a short time lapse, and to commit these picture to the same photographic 'plaque fixe'. After all, points and lines use up a lot less space than volumes. Yet, this endeavour also poses a problem. By refining the photographic techniques of his day,

Marey was able to generate very fine equidistant rows of points and lines that allowed him to visualise the desired repetition structures in a proportional way. When such rows of points become so 'fine' that they turn into solid lines, the numeric aspect of repetition slowly but surely retreats as analogue patterns take over, thereby hampering a detailed operative analysis of what moves and how exactly it does so. This problem cuts off the nose of this approach: that is precisely what happens when you create the possibility of representing analogue body movements on a digital level which is then refined to a point where the resolution of the digital image is such that one is forced to return to the analogue image!

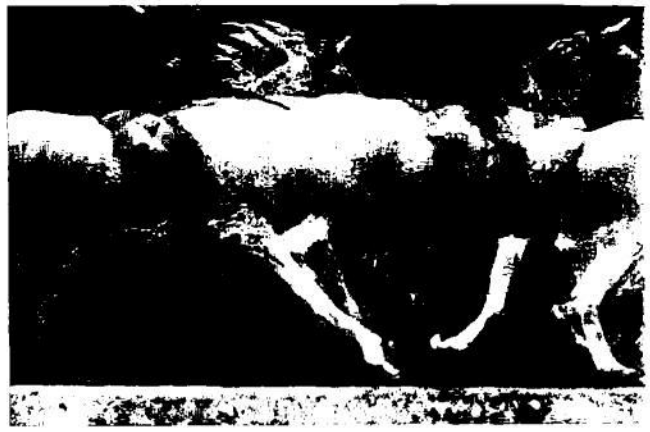
Faced with this stalemate, Marey decided to abandon his plate-shaped 'method' halfway through the 1890's and to use the achievements of the increasingly important cinematographic method. With this method, the impeccable registration and reproduction of reality by means of tape-shaped 'pellicules mobiles' became the end rather than a means. By abandoning his layer technique, Marey himself allowed it to sink into oblivion. Today, however, Marey's method has started a new scientific, architectural and artistic life, albeit in new shapes and forms. The end of this new evolution is not yet in sight.

The following seven illustrations show Marey's problem as well as his method for solving it.

4.17 TOO MUCH SOUND

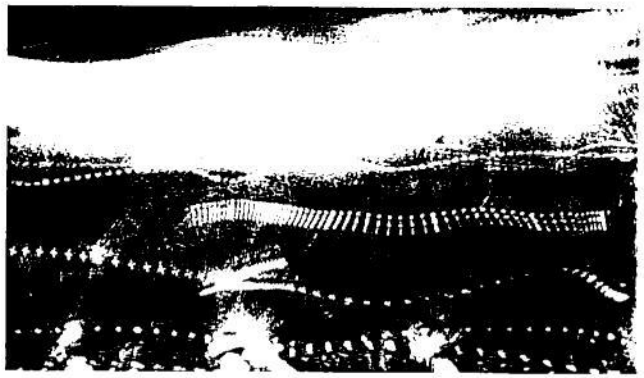
It strikes one as remarkable that Marey's problem can also be traced on the level of so-called interactive live-electronic music. While too much picture information leads to a loss of articulation in Marey's case, a similar phenomenon surfaces in the aforesaid musical genre when there is too much repetitive sound. After all, there is a lot of interaction going on, which implies that sounds can only be answered by repeating rather than imitating them. This leads to an illicit accumulation of sound, but also to too many harp-like, interfering line webs [3.12–3.15].

While Marey was able to impose a solution through 'digitisation', modern-day composers usually shy away from such radical operations. After all, sounds are sounding quantities rather than



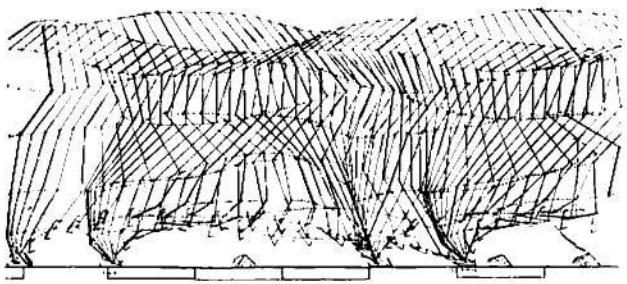
Ill. 31
'Plaque fixe' with a number of superimposed photographic pictures of a running horse. The separate moments of movement are relatively easy to identify.
(E.J. Marey, ca.1885)

Ill. 32
Same as Ill. 31, but with different layers. The pictures of the horse's body have been shifted in such a way that the various layers are almost impossible to identify and thus perceived as a 'body sausage'.



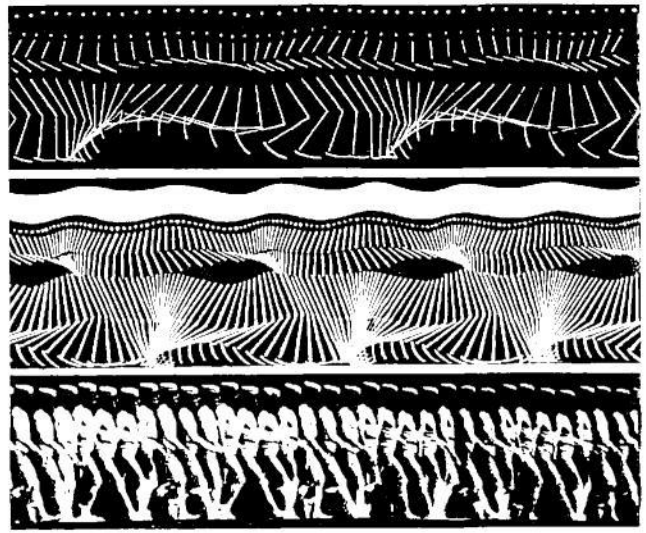
Ill. 33

Same again: a very special result. The speed of the repetitive photographs of the running horse was increased to a point where the horse's body appears to be a ghost-like 'ectoplastic' matter stain. That is why Marey painted white lines and points on the horse, so that the repetition structure assumes a discrete digital shape, while the various moving parts of the horse can be compared in a very articulate way. In short, the special aspect of this plate is its perfect balance between analogue and digital photographic representation of the horse's movements.



Ill. 34

Same again: the final, definitive stage. The line-and-point structure of the preceding image has taken a completely abstract, geometric, shape. This leads to an optimal, morphologically justifiable, correspondence between, on the one hand, the vertical, skeletonised body structure of the horse, with ears, head, neck, body, legs, and hoofs as separately moving members, and on the other hand the horizontal repetition and time structure used for capturing the horse's run so as to allow for a more detailed observation. From the point of view of a matrix, the contents of the X and Y axes are equivalent and thus interchangeable. The illustration could therefore be rotated 90°.



Ill. 35

E.J. Marey, the same as in illustrations 31–34, this time with a walking man.

abstract entities: that was Pierre Boulez' logic in 1981 when he presented his version of Marey's layered image, the 'horizontal arpeggio' that was generated live.

With a view to a verifiable musical solution, the preceding paragraphs [4.4–4.10] suggested to expand the more or less linear concept of 'sound' with a field-shaped matrix of equal vertical 'depth' and horizontal 'length'. This extensive transformation can only be meaningful after performing a radical reduction of layered sounds to numeric (or digital) point structures. This guarantees a natural correspondence between these two structure types in much the same way as with numbers in mathematics and letters in language. This is a necessary precondition for a workable and 'logical' system that allows one to study and 'compose' the morphology of sound.

Such an approach requires sacrificing some of the beauty and timbre wealth inherent to sounding sound, but this is more than compensated for by the presence of a composable morphological

sound system. When I put such a system into practice in 1964/65, the gain in those computerless times was considerable to say the least.

Quite unlike Pierre Boulez when it became clear that his key work *Répons* was based on a similar repetition principle, even though is was related to sounding sounds! [3.13]. While the aforesaid morphological method of the 1960's had to stick to bare pins and abstract sound matrices, *Répons* revelled in a blinding instrumental wealth only fifteen years later. This wealth, by the way, was able to conceal the essence of the interactive repetition problem from most listeners when applied to live instruments.

The comparison of both methods clearly shows which musical achievements need to be sacrificed in order to reach an ideal morphology of sound. As far as images are concerned, Marey was the first to understand this most clearly and to draw the unavoidable consequence of this insight by adopting a 'graphic method' reduced to the extreme. As stated earlier, Marey's successors never drew any additional conclusions from this, for they all turned their backs on the related problems.

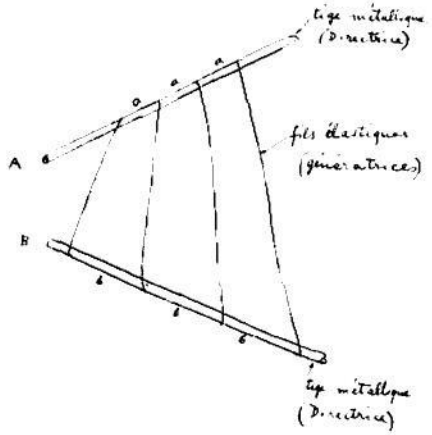
4.18 A MORPHOLOGICAL PRIMARY PLANE

Around 1956, the architect/composer Iannis Xenakis (°1922) produced an extremely elementary representation of a twisted, 'morphed' plane. The significance of this plane is that it has has both architectural and mental content. As such, it provided the foundation for the project of an audiovisual pavilion, *Le Poème Électronique*, that was put into practice on Philips' behalf under the supervision of the architect Le Corbusier at the occasion of the World Exhibition in Brussels in 1958.

This sketch is remarkable in various respects, the most important being that it allows one to show the principle of a 'morphed' plane in all its simplicity and intelligibility. Based on the above about the principles that lie at the hearts of sensible and correct morphological repetitions, such planes can be considered the result of repeating given basic patterns according to a plan and a more or less fixed repetition programme. This produces an unacceptable incongruence between the structure of the basic patterns and that of the repetition programmes whenever the basic patterns

appear to be analogue, while the repetition patterns are digital in nature. In Xenakis' sketch, however, this correspondence between both structures is optimised exhibits no incongruence whatsoever.

There are two horizontal bars (A and B) that are rotated with respect to each other and to which four vertical, elastic wires have been attached. These are influenced by three factors: P, R, and T. One of the four wires represents the 'primary pattern' (P) that is mirrored in the presence of the other three and thus virtually repeated. Consequently, Xenakis defines the ensemble of wires as 'génératrices', the 'basic elements'. It is through this pattern of the collective of four wires that the repetition structure (R) materialises. The moment of rotation or translation (T), finally, determines the degree to which the plane is being morphed. Xenakis, rather tellingly, calls this factor (T) the 'directrice', the element that specifies the direction.



Afb. 36
Iannis Xenakis, drawing of a twisted plane with four wires (1956)

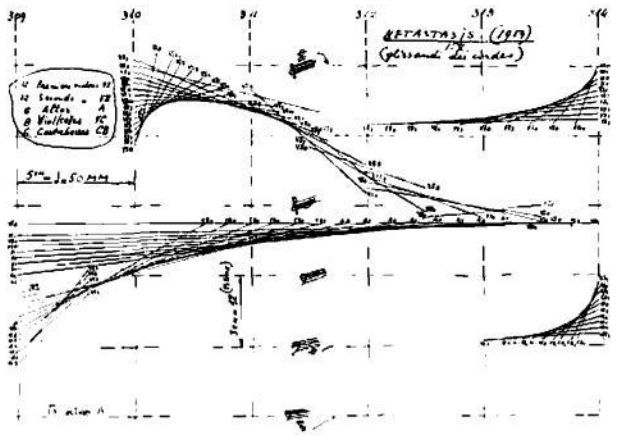
Xenakis' sketch was no accident: its forerunners were to be found in other, more or less non-committal, sometimes, playful geometric wire constructions by Naum Gabo (1890–1972) and Antoine Pevsner (1896–1961). What sets Xenakis apart from his predecessors,

however, is the rock-solid consistence that leads him to derive multiple complicated, mathematically rounded planes ('hyperbolic paraboloids') from this one simple, primary model, thereby putting them into practice at various occasions in the guise of organic, architectural, and musical spaces in a very convincing way indeed.

4.19 FROM A MORPHED PLANE TO A HARP-LIKE ARPEGGIO

Another remarkable fact is that Xenakis' primary model not only manages to express the twisted architectural 'liquid' plane but also that of repeated and layered sounds of morphologically composed sound. The first instances where this can be witnessed are, of course, Xenakis' own compositions such as *Metastasis* (1954) [Ill. 37] and *Pithoprakta* (1956). By the way, while dealing with Karel Goeyvaerts' electronic composition *K5*, a similar morphological idea surfaced, because he was concerned with the most ideal possible realisation of primary, rotable, or rather tiltable, crystalline sound aggregates: so-called standing sounds [2.1–2.3]. Goeyvaerts' underlying idea was to allow the active observer to experience these aggregates as constantly changing 'tiny sound stacks' while walking and tilting them [3.8]. This idea is essentially similar to that of Xenakis: the quest for a morphology of sound by means of repeating and piling up basic patterns so as to create sound shapes. From an instrumental point of view, these shapes are obviously presented 'upright', yet in a compositional way, they are equipped in such a way that they can present themselves to the active observer as a multitude of variable configurations.

Let us yet again return to Boulez' principle of 'horizontal arpeggios' in his work *Répons* [3.12–3.16]. Even though this idea is based on an utterly separate and different concept, its morphology and principle are fundamentally related to Xenakis' and Goeyvaerts' ideas. Even the construction of horizontal arpeggios is based on a morphological repetition programme that is related to the duplication and horizontal addition of predetermined tone and sound patterns. This is once again about the conception of standing elements that are only revealed during their perception (during a performance in a hall) in time and space.

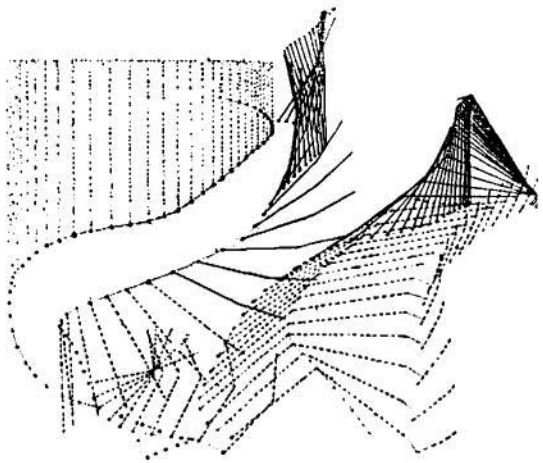


Ill. 37
Iannis Xenakis: Metastasis *for orchestra (1954): a morphologically composed spatial movement of sound in the guise of bundles of both diverging and converging glissandi, performed by as many separate string instruments.*

The simple analogy between Xenakis' rough sketch and the primitive drawing of a harp indicates that there is more than just an anecdotal relationship, especially on Boulez' part. Indeed: while a little goodwill is enough to consider this sketch an 'arpeggio' of strings that are plucked in succession when you play the harp, Boulez' understanding of the 'arpeggio' refers to the fan-like 'plucking' of space by means of point-shaped, auto-reproductive sound germs that generate themselves. As with Xenakis and Goeyvaerts, this does not refer to a superficial instrumental, but an intrinsically compositional act, whereby the originally passive observer is emancipated to the level of active, creative composer. The fact that the 'arpeggio' concept, as a direct derivative of a musical instrument, can be considered a 'harp' only corroborates this correspondence. This is therefore no accident.

4.20 MORPHOLOGICAL SPACE: AN ANALOGY

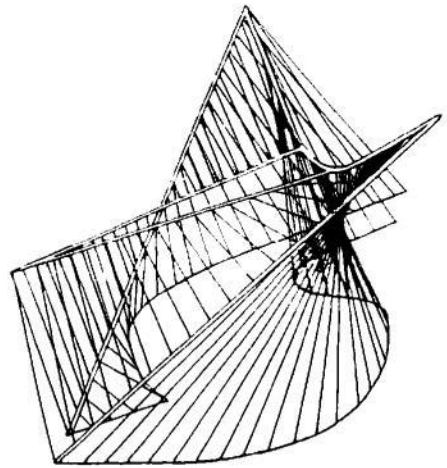
Let's go one step further still: Xenakis expands the morphological curved, primary plane with various other curved planes to a single architectural space. This leads to the emergence of unexpected



Ill. 38
E.J. Marey, a jump from a chair, graphical geometric representation rotated 90° (1884)

analogies with other image constructions, more specifically those produced by Marey some seventy years earlier, and thus to the following comparison:

Marey's graphic image reveals a striking similarity with Xenakis' geometric space designed in 1956 for the Philips pavilion in Brussels (Ill. 39). In Marey's case, the lines painted on the body of the jumping person engage in twisted, 'morphed' relationships under the influence of the spatial jumping movement. This leads to the creation of curved systems of 'primary planes' that, from a fundamental and systematic point of view, correspond to the arched, liquid spaces Xenakis designed some seventy years later. In this respect, one might say that the way in which Marey succeeded in committing his images to 'plaques fixes' using photographic tools in the late 19th century is essentially analogous to Xenakis' shaping of spaces by means of 20th-century compugraphic methods. This analogy is essential by virtue of the way in which Marey repetitively twisted a given basic item — the 'génératrice' P, as an



Ill. 39
Iannis Xenakis, preparatory study for the Philips pavilion (1956)

abstract line system — based on an equally abstract frame structure R and the torsion momentum, the 'directrice T'.

Through this extraordinarily graphic notation of sound structures, Xenakis, the composer, is clearly ahead of Xenakis, the architect. The underlying idea of these composed 'liquid forms' is the substitution of obscure collective string glissando movements with imaginary curves of an abstract mathematical kind. To this end, a system of tangents is performed by groups of string instruments, with the intention to have the various totals of all tangents move towards the listener as inductively generated, curved 'meta sounds' rather than a mishmash of simultaneous glissandi. (In a similar way as arched bridges whose various 'cores' of stays need to be experienced as total planes rather than systems of separate lines.)

One can but applaud Xenakis' attempt to lump together architectural and musical spaces in a morphological sense. By doing so, he can be said to have founded today's transarchitectural hybrid world of shapes, or to have anticipated it at the very least.

4.21 LIQUID FORM (1)

We are now closing in on the area of modern compugraphics. These are used for visualising dynamic, 'liquid' architectural shapes that cannot be represented in any other way, not to mention that they couldn't possibly be put into practice. This advanced 'graphic method' could appear to be miles apart from the severe stacking of picture layers as advocated by Mondriaan, the painter, and equally removed from aound layers as advocated by Goeyvaerts, the composer. That is only seemingly so because we are essentially dealing with the same generative shaping principle.

Stripped to their bare essentials, shaping both curved architectural spaces and 'liquid' electric sounds are both to do with a morphologic repetition (R) of a basic pattern (P) according to predefined translation or torsion programmes (T). These programmes take care of the directions in which basic patterns are translated and twisted. While discussing the work of the physiologist Marey, the composer Boulez, and the architect-composer Xenakis, it became clear that these three entities could be seen in relation to one another and that different disciplines — motion analysis, music and architecture — can indeed correspond to one another from the point of view of their morphological structure.

4.22 LIQUID FORM (2)

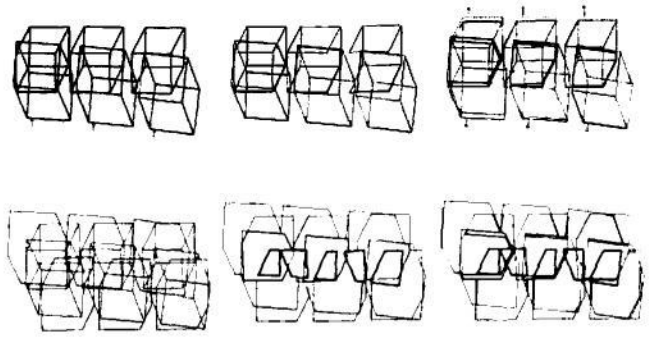
A telling example of the importance of a good working repetition programme is to be found in the theoretical-educational and architectural work of the American architect Peter Eisenman (°1932). Not only did he study such programmes in minute detail, he also expanded and deconstructed them from the point of view of dimensional units. It is typical of Eisenman to first shape his architectural concepts into diagrammatic realities — the realities of a flat drawing board where dreams can be dreamt — and to have them interact with concrete spatial construction afterwards.

In his book *Diagram Diaries* (Thames and Hudson, 1999), Eisenman shows how his conceptual diagrammatic operations relate to his concrete architectural buildings. In all instances, the translation and torsion of repeating patterns in the aforesaid sense

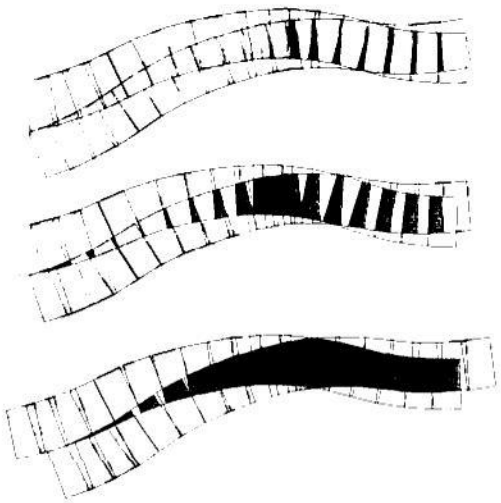
are expanded, refined, differentiated and divided into two categories: 'formant tools' on the one hand, and 'conceptual tools' on the other. This allows him to differentiate between an amazing number of morphological transformation operations, some of which (in an unsystematical order) are: twisting, extension, displacement, morphing, intersection, projection, torquing, distortion, warping, superposition, repetition, shifting, scaling, transformation, rotation, doubling, inversion, folding, layering, and so on.

It is extremely significant that a number these terms have already been used in this paper, even though they may have been related to the act of morphologically shaping musical sounds and — for the sake of clarity — usually to images from the visual, scientific, graphic arts, and architectural worlds. In any case, the congruence between Eisenman's conceptual operations on a topographic level and the morphologic structuring of sound is more than just coincidental and appears to be essential.

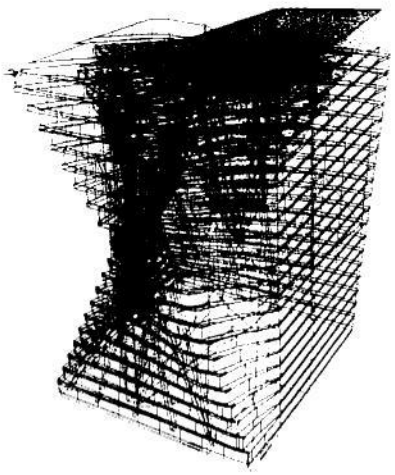
Let us look at three examples (Ill. 40, 41, 42) among the multitude of manipulated basic shapes in Eisenman's work so as to look into both associative and actual relationships with the rotation movements of Iannis Xenakis' sound hexaeders (Ill. 3). Pierre



Ill. 40
P. Eisenman; repetition, doubling (Carnegie-Mellon Research Institute, Pittsburgh-Pennsylvania, 1987/89)



Ill. 41
P. Eisenman; superposition, warping (Aronoff Center for Design and Art, Cincinnati-Ohio, 1988/96)



Ill. 42
P. Eisenman; morphing, torquing (Haus Immendorff, Düsseldorf, 1933)

Boulez' horizontal arpeggios, and the auto summation of sound patterns of Karel Goeyvaerts and myself.

4.23 LIQUID FORM (3)

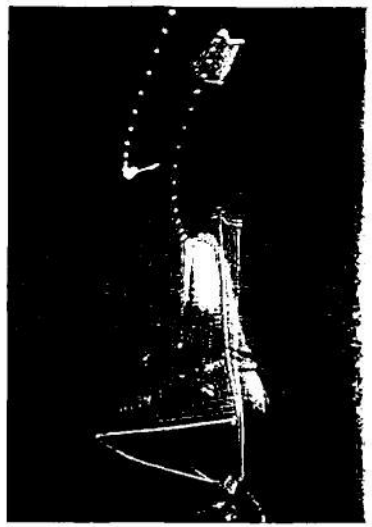
The congruence between Eisenman's architectural diagrams and morphological sound shapes can only be understood when one keeps in mind the quest for a far-reaching exteriorisation of sound in serial compositions between 1950 and 1970. Based on the decision to apply an equal treatment to all musical parameters, entities such as pitch, timbre, duration, horizontal and vertical layers, performance techniques, and so on, could be 'physicalised' and adequately visualised. A multitude of so-called graphic scores and theoretical treatises used regular notation symbols alongside graphic patterns and hence also graphics alongside signs. This clearly refers to an expansive shift from tone to sound, and thus from language to speech [1.9 and 2.7].

It is remarkable that the attempts of serial music to 'spatialize' itself on a topographic level by means of graphic representations were followed by Eisenman's 'musicalisation' of fixed shapes. He allows those shapes to move, warp, flow, shrink, overlap, interfere with one another, perform retrograde movements, etc., on his drawing board in a musical (playful) but nevertheless methodic way, not with the intention to prescribe these models as a mandatory diktat, but rather to be able to experience their inspirational, associative and inductive effects.

One could say that all this helped to achieve one of the main objectives of serial composition, i.e. the emancipation of (sound) matter, time and space, probably not literally but in the spirit, thanks to architects like Eisenman who expanded and shaped these concepts. They did so without supervision or a clear presence of such a 'liaison' with music in their ideology. Far from it: over the last decades, modern architects have come to refer to philosophical, literary and social models rather than musical ideas. The bulk of contemporary music is indeed egocentric, refuses to be connected to anything, wants to be 'free' and therefore has nothing to offer for contemporary architecture from a constructive point of view.

4.24 LIQUID FORM (4)

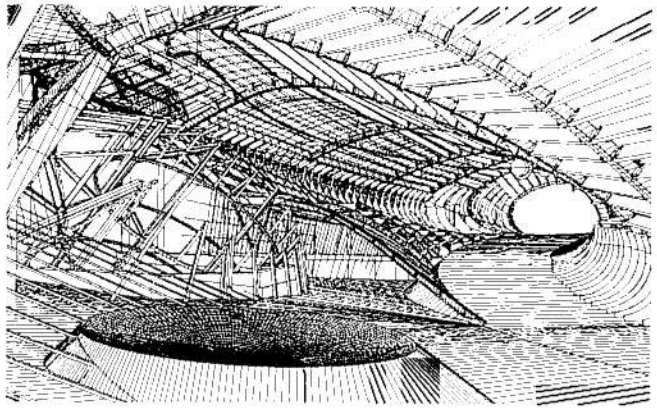
By way of conclusion, here are three illustrations where liquid and thus process-based movements of human bodies will be compared with those of 'morphed' architectural shapes. To this end, illustrations 43 and 44 show two kinds of dynamically twisted movements recorded onto glass-shaped carriers. In the first case, the movement really did take place, while in the second instance it was idealised in the hope that it may one day materialise. In the first case, the carrier is one of Marey's glass 'plaques fixes' from 1886, while in the second we are dealing with the glass front of a computer monitor on the desk of a contemporary architect. Both are made of glass and thus transparent, an illusion, they does not exist. This is a remarkable material correspondence, even though the contents are different.



Ill. 43
E.J. Marey, a chronographic illustration of a man jumping off a chair (1886). (See also Ill. 38)

Though anecdotal, the correspondence is essentially fundamental. A jumping movement as recorded by Marey suggests utter liquidity (evidently until the moment when the jumper's feet touch the rigid floor). In the case of the physiologist Marey, the movement is obviously headed downwards, while in the case of the architect Spuybroek, the building moves upward in an idealised fashion, with the intention to touch the sky. As for illustrations 38 and 39, the correspondence between illustrations 43 and 44 lies in the morphological structure of curved planes with respect to each other. Except that the planes have evolved into image aggregates of layered basic patterns whose horizontal length equals their vertical depth. It is precisely the length and depth that allow to show their twisted and translated qualities, so that we can experience these qualities as 'liquid'.

Ill. 44
Lars Spuybroek, compugraphic sketch of a multifunctional tower building in Noordwijk (The Netherlands, 1997).



Ill. 45
Kas Oosterhuis and Lars Spuybroek, Dutch architects, a blueprint made with compugraphic tools for the so-called 'H2-O Zoetwaterpaviljoen Neeltje Jans' near the Oosterscheldedam (The Netherlands, 1997)

This computer graphic clearly shows how the three units — basic pattern (P), repetition pattern (R), and translation pattern (T) — interact on a geometric level, thus producing a diversity of liquid forms. The fact that the pavilion should topicalise the continuous exchanging interaction between freshwater and salt water gives it more strength as utopian work of art than as a public territory. Upon entering this system of snake-like rooms, electronic sounds start playing, while the colours change in equally 'liquid' tempi. The sum of this seems to be a virtual snapshot of a dreamed reality where space, sound, colour and time merge into one. The room has thus been 'composed' and its static element has been 'dynamised'. And that's how ideal 'composed space' comes about.

POSTFACE

In this paper, especially in its final chapter, I have tried to pinpoint and discuss certain fundamental correspondences between morphological shaping of electric sound and that of architectural images. To this end, I gladly used the work of the French physiologist Etienne-Jules Marey as an inspiring intermediary model. Searching for and showing such correspondences is not a gratuitous luxury given the lack of interest of contemporary music for the constitution of new morphological sound systems. Any interest that may be there goes no further than imagining future holophonic and holographic spatial entities where one can feel at home and where pleasant and exciting virtual journeys can be made on a consumptive level.

While the bulk of contemporary musical practice is working on presenting one-dimensional shows and plays for passive consumers, modern architecture is advancing at such a pace that the gap may well become unbridgeable in the near future. On a scientific level, a new kind of pluri-dimensionality has surfaced that is both technologically advanced and highly democratic. These new areas span from 'reading' tomographic MRI scans by radiologists in the medical field all the way to the creation of virtual images by means of so-called CGI techniques (not to mention the possibility to travel to all kinds of Internet sites open to representatives of all social levels rather than just persons with special privileges).

As far as morphologically structured images are concerned, we are usually dealing with dreamt representations that, for the time being, can only be simulated by means of audiovisual tools. The future task, however, will be to put those dreamt images into practice: reality. Art has the privilege and the mission to shape, regardless whether matter-of-fact reality wishes to borrow the experiences gathered in this process. In that respect, true art has always been unselfish, something which is not likely to change in the future.

CAHIER-M was to give the reader a glimpse of the world of the morphologically layered, pluri-dimensional image that may well become reality over the next decades in various electric, aural and visual ways. The author of this paper wanted to and succeeded in acquitting himself of this task by projecting this close reality onto the imaginary 'future plane' from an equally close past. This called for an unorthodox approach. But that is exactly what this paper was all about.

PERSONALIAE

DICK RAAIJMAKERS

"Minuscule ideas coupled with mega-elaborations," is what the press calls Dick Raaijmakers' work. He is one of the founders of the electronic music scene in the Netherlands. A composer, essay writer, theatre director and plastic artist, Dick Raaijmakers can look back on an impressive series of works. In all of his endeavours, he focuses, in one way or another, on the relationship between art and technology. The same can be said of *Cahier-M*, his latest publication.

Dick Raaijmakers (Maastricht, 1930) studied at the Royal Conservatory in The Hague (Netherlands). From 1954 to 1960, he was employed by Philips in Eindhoven where he worked on electro-acoustics. He then accepted a post as scientific collaborator at Utrecht University for an assignment that lasted until 1962. From 1966 until his retirement in 1995, he was a professor at the Royal Conservatory in The Hague, where he taught Electronic Music, and from 1991 also Music Theatre.

Raaijmakers was awarded several prestigious prizes for his contribution to the evolution of plastic and musical arts in the Netherlands: the 'Œuvreprijs voor beeldende kunst' (Plastic Arts prize for his entire work) by *Stichting Fonds voor Beeldende Kunsten, Vormgeving en Bouwkunst* in Amsterdam, the 'Matthijs Vermeulen prize' by *Amsterdams Fonds voor de Kunsten* in 1994, and the 'Ouburg prize' for his entire work awarded by the *The Hague City Council.*

Publications:
De kunst van het machine lezen [The Art of Machine Reading] (1968)
The Electric Method (1981)
De methode [The Method] (1984)
De val van Mussolini [Mussolini's Fall] (1984)
Neo-plasticisme versus Neo-Bechstein (1988)
Open muziekinstrument [Open Musical Instrument] (1989)

Over zitten voor elektrofonen [About Sitting in front of Electrophones] (1992)
Stomme film [Silent/Dumb Movie] (1992)
Fort-Klank (1993)
De gecomponeerde stilte [Composed Silence] (1993)
The Future of Electronic Music (1995)
Over tonale en atonale machines [About Tonal and Atonal Music] (1996)
Het kleinste geluid [The Smallest Sound] (1997)
Lichte muziek [Light Music] (1997)
Gecomponeerde ruimte [Composed Space] (2000)
Cahier-M (2000)

His recent music theatre productions include:
Intona (1991)
Dépons Der Fall (1992)
Die glückliche Hand geöffnet, collective (1992/93)
Der Fall Dépons (1993)
Fort-Klank, collective (1993)
De Promenoir van Mondriaan, collective (1994)
Der Stein (1994/95)
De val van Mussolini (HF-1995)
Hermans Hand (1995)
Scheuer im Haag, collective (1995)
De Weergave (2000)
Kwartet Heiliger Dankgesang (2000)
Konzert für ... (2000)

His complete electronic work for tape was released on CD in 1998, together with an extensive documentary book published by NEAR/Donemus (Amsterdam).