

Visualising Sound – Sonifying the Visual

Clarence Barlow, June 2004

The visualisation of musical sound can be pursued in a number of ways, two of which are rooted in **technical** considerations: the music could be intended for human performance, resulting in the development of a prescriptive performance score. If electroacoustic components are present in this music, these are often included as a graphic depiction (e.g. of the sound wave or as a sonagramme, or one reflecting the compositional methods etc.), thus more properly fulfilling a second main function – a descriptive one, mainly used in documentations, lectures and/or study scores (e.g. Ligeti's *Artikulation* or Stockhausen's *Electronic Study II*), but also sometimes prescriptively as part of a sort of (re-)construction kit.

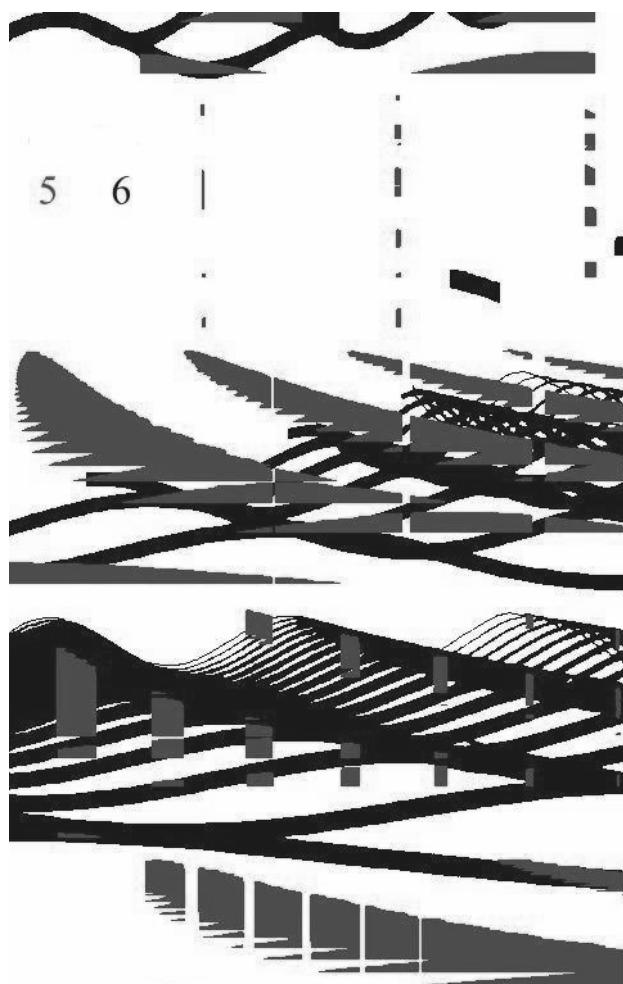
Two other different approaches are rooted in the **aesthetical** (and possibly the synæsthetical): in sound visualisation it could simply be sound-derived images that satisfy; in the converse, image sonification, it could instead be the pleasure of extracting convincing music from optical sources, a comparison of source and result adding to the enjoyment. In multimedia such as film it could be the counterpoint of sound and image that pleases, especially if these are clearly bonded to another as when sound visualisation or image sonification is involved.

In the above, the vectors prescription-description and visualisation-sonification can work both ways, i.e. a prescriptive score is also potentially descriptive, one could (re-)imagine a visualised sound aurally, a sonified image visually.

In this presentation I would like to concentrate on these latter (syn-)aesthetic aspects as exemplified in my own work of several decades, having long been fascinated by the links between sound and image. These links mainly involve the concepts of Position and Motion as well as of Colour, all of which are not only important aspects of music but fundamentally spatial, ultimately visual concepts: in musical contexts one speaks of "high" and "low", of "fast" and "slow" (all of which comprise spatial terms – for instance the tempo indication *andante* literally means "walking") as well as of "bright" and "dark" sounds and of "sound-colour". Starting over thirty years ago, I have especially in recent times been repeatedly drawn to enacting these parallels. The first five examples are of sound visualisation, the last five (plus a footnote) of image sonification.

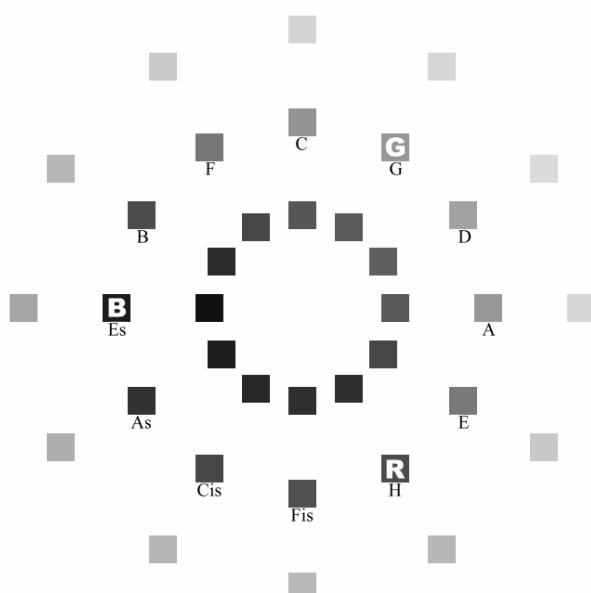
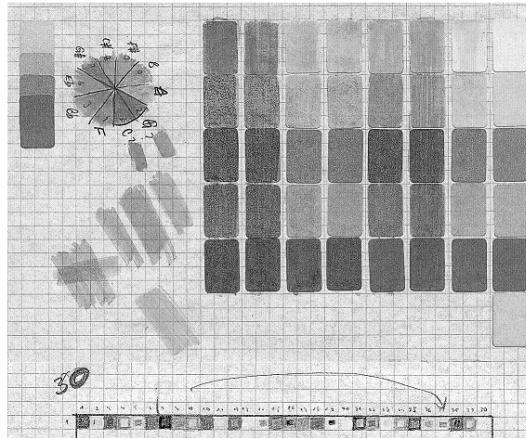
I. Sound visualisation

1. *Sinophony II* (1972)



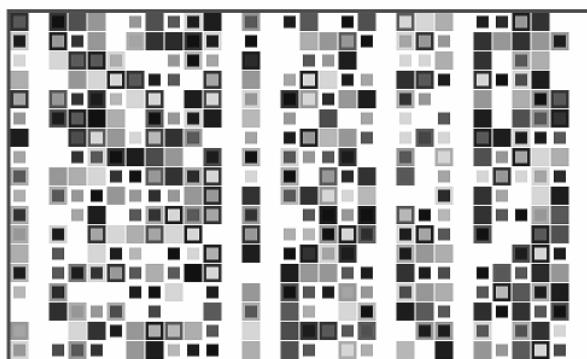
This purely electroacoustic composition was realised for eight channels in the studios of EMS, Stockholm in December 1972. It consists wholly of sine-tones (cf. the title), the frequencies of which are in theory unbounded, the dynamics likewise (though mercifully downwards only) as also the duration. Due to the technical limitations given at that time, I limited the frequency range to 17-17000 Hz, the dynamic threshold to -60 dB and the duration to 24 minutes. Just after the audio realisation, I thought a graphic study score would be probably very nice and plotted the same at the main computer of Cologne University during early 1973. The result in A2-poster size has been available from my publishers Feedback Studio Cologne since the summer of 1973. Here at left is a more recent reconstruction of an excerpt of channels 5 and 6 in two shades of grey (representing red for 5 and blue for 6). Time is shown on the X-axis. Each sine tone is depicted as a horizontal strip, its bottom edge showing the frequency measured on the Y-axis and its width giving the amplitude.

2. Relationships (1974) – Version 4 (1976) for two pianos

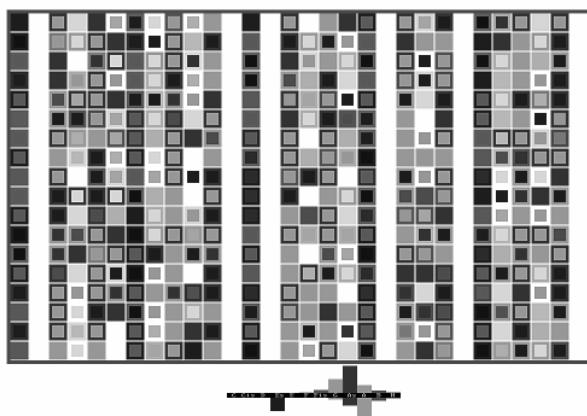
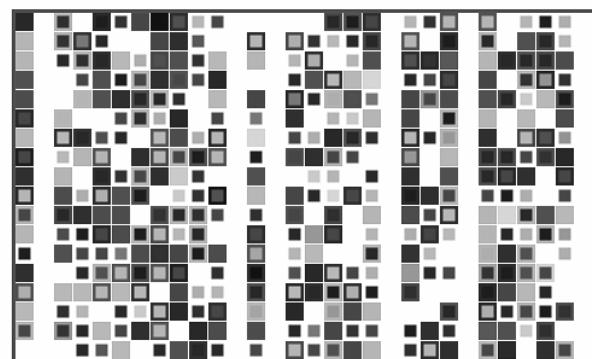


In this piece, the twelve classical chromatic pitch-classes are subjected to probabilistic distribution in such a way as to create variably tonal pitch-fields and variably metric pulse-fields, ranging from the practically atonical and ametrical to the clearly tonical and metrical. The metric structure is based on a thirty-pulse cycle. While composing the piece I had an idea for visualising these situations: the twelve pitch-classes were to be shown by the well-known twelve-colour circle whereby the note B was given the colour red, G yellow and E-flat blue (shown as “R” for the German *rot*=red, “G” for *gelb*=yellow and “B” for *blau*=blue in the grey-shaded diagramme at left). Also, three dynamic levels were indicated by the admixture of white (for softer) and black (for louder). The thirty pulses were to be shown as a row of thirty double squares, a small one for piano no.2 inside a larger one for piano no.1 – see the bottom of the checkline paper example at top left. Every pulse cycle would need a new row of squares. I created 30 colours (the notes D and E are missing in the piece) by mixing different amounts of red, yellow, blue, white and black pigments and applying the mixes to self-adhesive white paper labels (see top left again), but it was the next step that stumped me – manually sticking about 70,000 hand-coloured labels to white paper. I gave up after a short time, and after waiting about twenty-five years programmed the examples shown in grey shades on the next page in Linux – they represent four different sections of the piece, the two at the top ametrical and the ones at the bottom metrical (seen here by the vertical lines), the two at left atonical and the ones at right tonical (seen here by the similarity of colour shade). The histogrammes at bottom show the relative probabilistic distribution of the twelve pitch-classes.

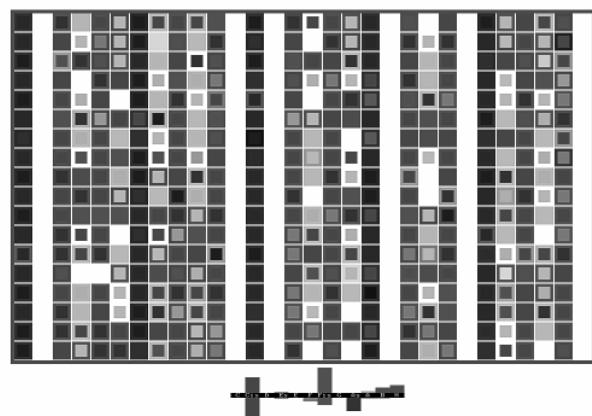
Ametrical-Atonical music



Ametrical-Tonical music

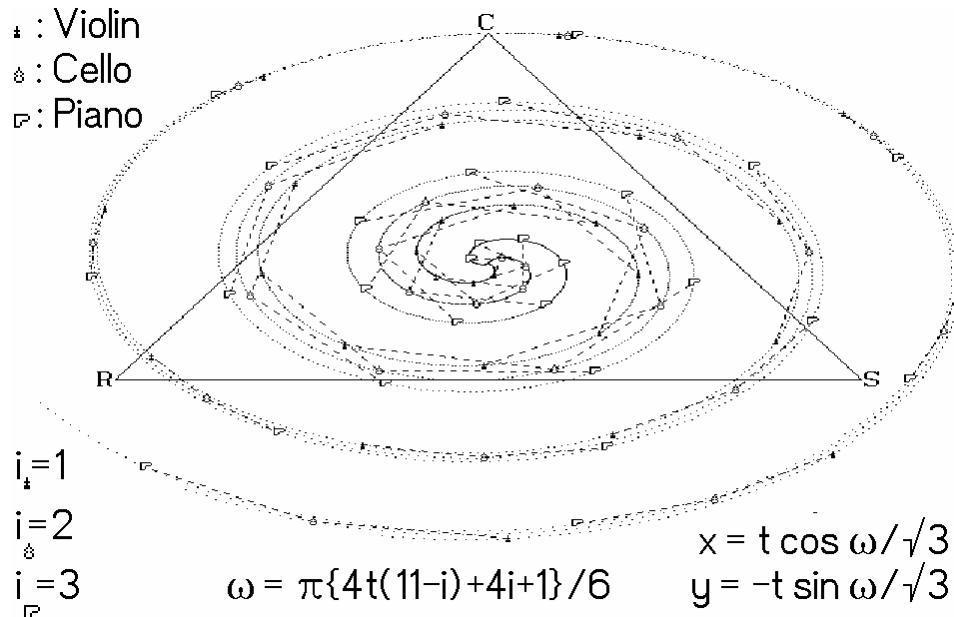


Metrical-Atonical music



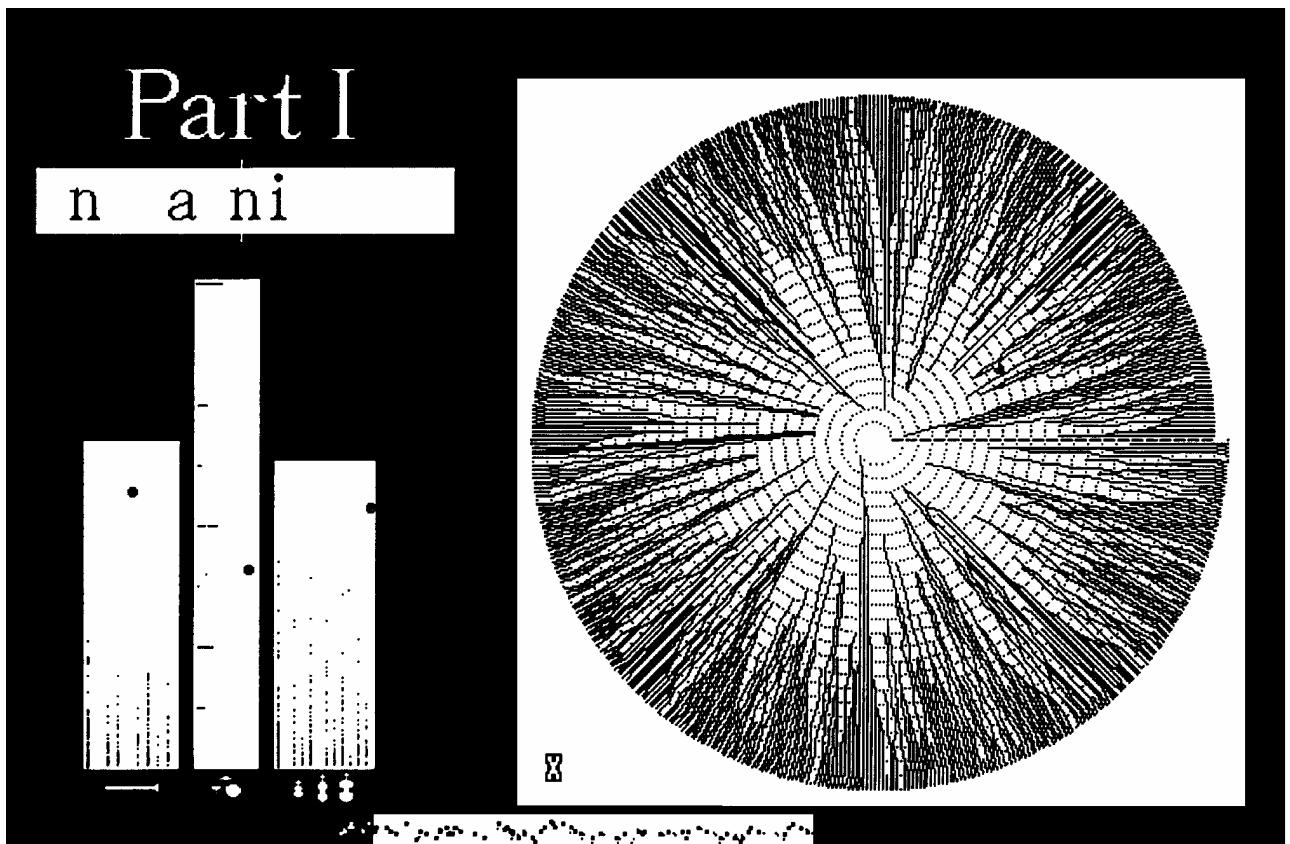
Metrical-Tonical music

3. 1981 (1981) for Piano Trio



The music of each of the three instruments of this piece – 1. Violin, 2. Violoncello and 3. Piano – resulted from the statistic manipulation of the corresponding instrumental parts of the following three works: *La Chasse* by Clementi (in C of 1788), Schumann's 2nd *Piano Trio* (in F of 1847) and Ravel's *Piano Trio* (in A-minor of 1914). The first movements of these pieces were so applied, that all begin together and finish about forty seconds apart in the order Clementi, Schumann and Ravel. The diagramme depicts the compositional makeup of the piece with the instruments shown as periodic icons along spiral arms: at the beginning, all three – at the midpoint of the graph – have equal amounts (33%) of each composer's music, because the closeness of an icon to an apex of the Clementi-Schumann-Ravel triangle corresponds to the proportional amount of the music of that composer.

4. *Im Januar am Nil* (1984) for chamber ensemble



Im Januar am Nil (=In January at the Nile) was written in 1981 for the Cologne group *Ensemble Köln* – the instrumentation: two soprano saxophones, percussion, a piano, four violins, two cellos and a double-bass. In 1984 the completely revised piece was premiered in Paris by *Ensemble Itineraire*. In 1993 I made a MIDI-realisation using instead of sampled instruments only classical electronic sounds - sine, sawtooth, square and pulse waves as well as filtered white noise; this was premiered in the Bourges Festival of 1996. In 1999 I also made a video film to match this synthetic realisation, of which the diagramme shows one frame.

Through the piece runs a melody repeated 24 times, growing each time both in length and density – new tones appear in the expanding gaps, first in a purely auxiliary function, but gradually harmonically rivalling the older tones. A single note at the start develops into a flowing melody moving from transparent tonality through multitonality to a dense self-destructive atonality. At first the melody is played almost inaudibly by the bass clarinet, amplified by overtones heard as natural harmonics in the strings: the resultant timbre is phonetic, based on a Fourier analysis of German sentences (as for instance the title itself) containing only harmonic spectra, namely liquids, nasals and semi-vowels. Ideally these “scored Fourier-synthesized” words should be comprehensible, but an ensemble of seven strings can only be approximative.

The diagramme shows at right the rhythmic scheme as a spiral, of which each arm corresponds to one generation of the melody. The “ball” seen in the 10th generation at about the two o’clock position shows the pulse current to the given frame. The dots at bottom middle reflect the pitch structure of the 10th generation with the moving left edge of the black-on-white part at the current pulse. The text below the words “Part I” at top left represent the phonetic elements being currently heard. Finally the three boxes at left show interjections by the winds, percussion and strings – whenever one of the moving balls in the boxes touches one of the dots in the several strips therein, a loud sound is emitted by the corresponding instrumental group, independent of the melody at the bottom.

5. ...until...(1972) – CD-Cover design (2003)

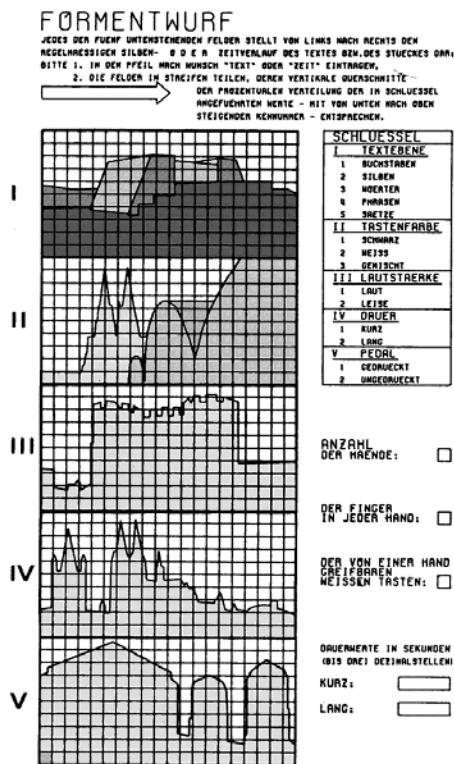


Conceived in 1972, this piece consists of a cyclic melody, its pitches initially consonant against a constantly sounding drone. Little by little, the pitches give way to more dissonant ones; towards the end, a slight pitch-adjustment of the drone reveals the new pitch constellation as a pitch- and phase-shifted transposition of the original. There are to date nine versions of ...until..., for instruments ranging from solo violin or guitar to a Jazz group or even an ensemble of North Indian musicians.

When requested in 2003 to design the cover of a projected CD of Version 5 (1974) for solo piano, I decided to apply the compositional principle to pixels instead of notes: a photograph by Behr de Ruiter of Amsterdam buildings facing the electroacoustic music institute STEIM and downloaded from the Internet was separated into its constituent red, green and blue pixel components. Each of these monochromatic images was then faded from left to right into an X- and Y-shifted version of itself – one can see for instance in the final picture how the gables on the left gradually “dissolve” into the sky on the right, where new gables form more solidly a bit below and a bit to the left. As can be expected, the three new pictures in their respective red, green and blue were merged to form the CD cover picture as seen in a greyscale equivalent above.

II. Image Sonification

1. *Textmusic for piano* (1971) – Plan for and initial bars of *Version 8* (1973)

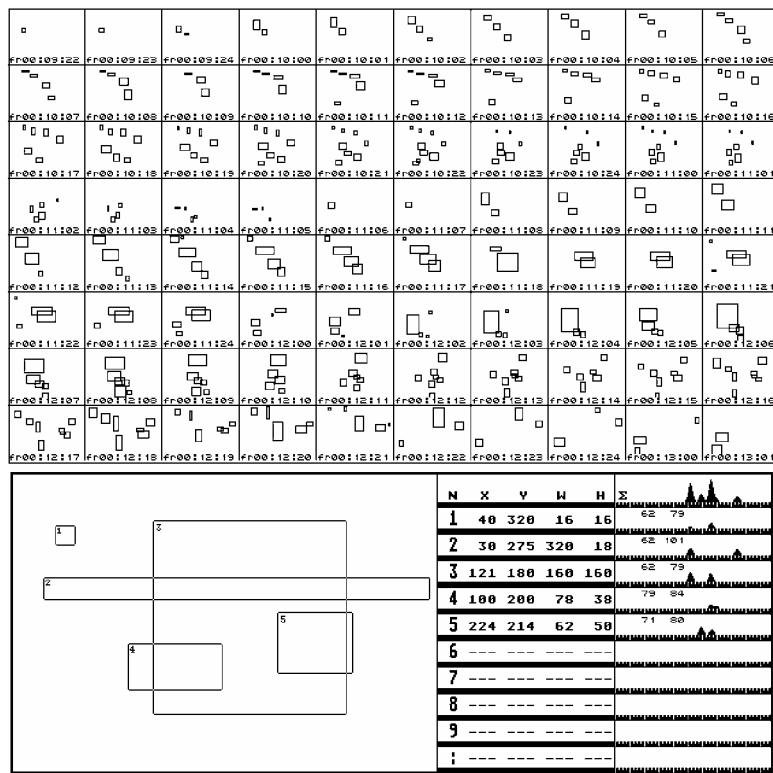


Textmusic No.8 (VIII'73)

Piano

Version 8 of 1973 was based on a text in Cologne dialect (a Moselle-Franconian language akin to Dutch) praising the virtues of that city in various ways. It seemed appropriate to relate the curves in *program txms* in some way to the object of the text's adulation: postcard photographs of I. the Opera House, II. the Cathedral and the Hohenzollern Bridge, III. the *Hahnentor* or West Gate of the mediæval city, IV. a Rhine panorama with the Cathedral and the Church of St. Martin Major, and V. the 10th century Church of St. Gereon were applied as parametric curves (see the diagramme at left). The musical result bears audible links to these curves; e.g. curve II, which prescribes an initial key-colour distribution of 90% mixed-chromatic and 10% white-diatonic and a final one of 100% black-pentatonic keys (due here to the proximity of the Hohenzollern Bridge at the picture's right end) as borne out by the scored examples on the right – the upper shows the beginning, the lower the end of the piece.

2. Estudio Siete (1995)

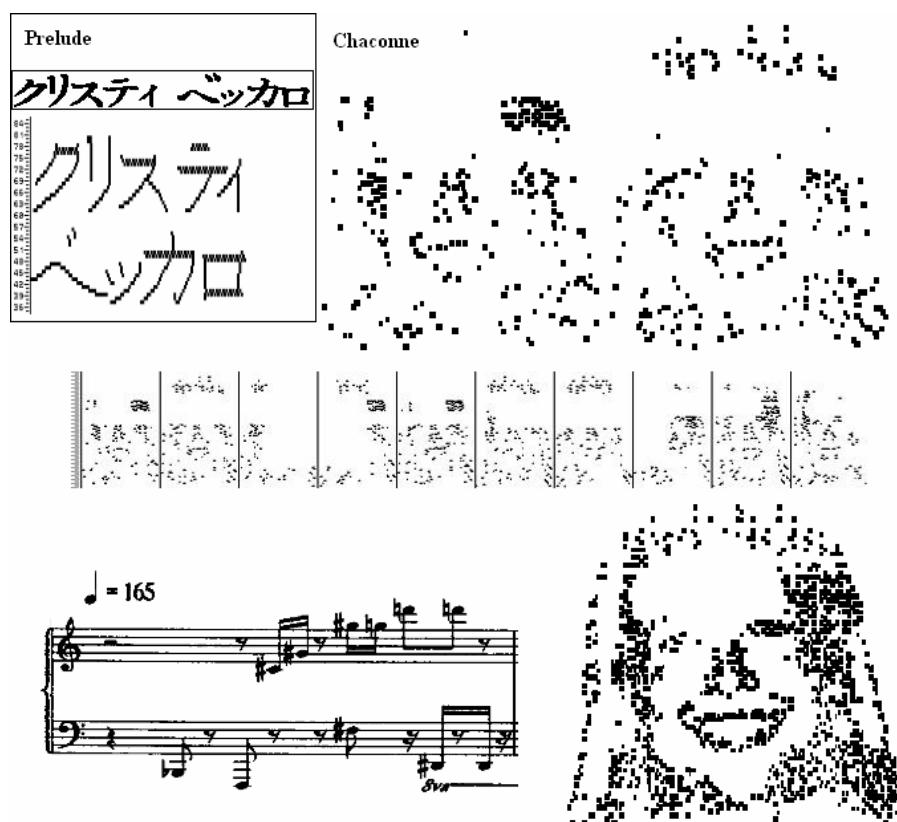


In 1995 I was commissioned to contribute to the *One Hundred Years of Film* festival of the Bonn Kunsthalle with music to be synchronised to the 1930 film *Study No.6* by Oscar Fischinger. The original music by Jacinto Guerrero, to which Fischinger had synchronised his images, was to be confronted by a more contemporary work.

One of the layers of the composition is a metamorphosis of Fischinger's dancing objects; here I effected a phonetic correspondence between the shape of the objects and the sound colour of a resulting tone-cloud - horizontally stretched shapes yielded (similarly to the human mouth) an [i] ('ee') sound, squat shapes an [u] ('oo'), with sonic interpolations for in-between shapes.

Estudio Siete (Spanish for "Study" or "Studio" No.7) was composed in Cuenca near Madrid and realised in the studio that I head in the Royal Conservatory The Hague (Studio 7). It is best heard film-synchronised on a player piano.

3. *Kuri Suti Bekar* (1998)

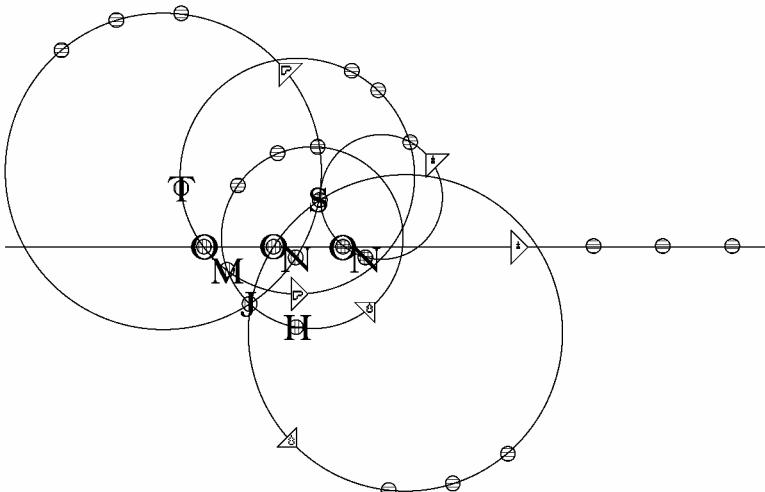


Written for the pianist Kristi Becker on her 50th birthday, *Kuri Suti Bekar* consists of a Prelude and a Chaconne.

The Prelude, lasting twelve seconds, is a sonic translation of the pianist's name written in Japanese Katakana script (see top left in diagramme) - the sounds *ku-ri-su-ti bek-ka-(ro)* are the closest one gets here - the right hand plays *ku-ri-su-ti* and the left hand *bek-ka-ro* simultaneously, the vertical graphic axis being pitch and the horizontal time.

A similar graphic pitch/time representation of the Chaconne reveals ten successive “pictures” corresponding to ten pages (at sixteen seconds each) of the score. A superimposition of these ten images mirrors a scanned photograph of the pianist's face: the choice of pitches derive harmonically from Version 5 of the composer's 1972 piece ...until..., which can optionally be played synchronised with the Chaconne. Another pitch source was the phonetic analysis of the three Bengali words *kuri* (=twenty), *suti* (=cotton threads) and *bekar* (unemployed), the title of the piece.

4. *Les Ciseaux de Tom Johnson* (1998)



Les Ciseaux de Tom Johnson

Flûte

Clarinette

Trompette

Piano

Vibraphone

Alto

Violoncelle

p sempre staccato e crescendo lunga

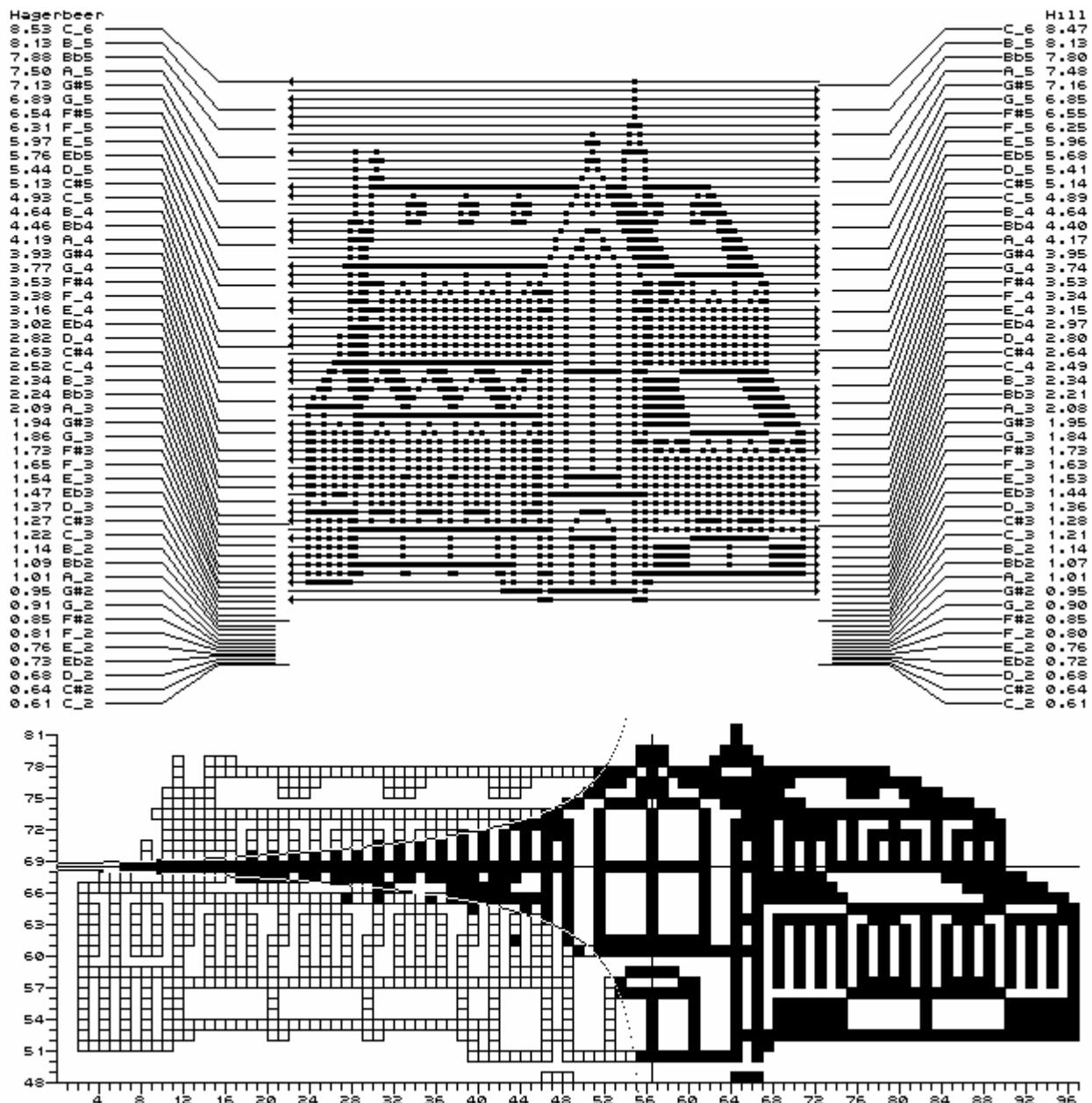
Instructions for manufacturing *Les Ciseaux de Tom Johnson*

1. Write the letters T, O, M, J, O, HN, S, O, N from left to right, their alphabetical order reflected in their position from bottom to top.
 2. Sketch 6 circles through the letter combinations ‘TOM’, ‘MJH’, ‘JOS’, ‘JNS’, ‘SON’ and ‘OOO’, the last group in a straight line, i.e. an infinitely high-centred circle.
 3. Allow the six letter combinations to move anticlockwise along their respective circles by $1/90^{\text{th}}$ of the circumference of the smallest (‘SON’-) circle: doing this 90 times in all causes all groups to traverse variously sized angular distances, ‘SON’ going full circle.
 4. Scan the 91 obtained configurations each by an imaginary vertical line moving smoothly from left to right: the height of all letters encountered by the line gives pitch (alphabetically chromatic), the moment of the encounter gives time: the pitch-time interpretation yields a musical “mini-score”.
 5. Place the 91 mini-scores along a time axis, such that the time gap between any ‘OOO’ group and the next is equal to the gap between the ‘O’s in themselves, i.e. so that all 273 ($=91 \times 3$) ‘O’s are temporally equidistant. Insert a small pause at the end of the first mini-score.

Voilà, *Les Ciseaux de Tom Johnson* is complete! (see the score for an example of the first nine bars)

✓ Ch., Les Ciseaux de Tom Johnson is complete. (see the score for an example of the first nine bars)

5. *Le loup en pierre* (2002) for two organs



This piece ("The Stone Wolf") was composed for the two organs in St. Peter's Church in Leiden, the mean-tone-tuned Van Hagerbeer organ with A=419 Hz and the equal-tempered Thomas Hill organ with A=440 Hz. The first section of the piece involves a sonification of a sketch of the church building, calibrated to the so-called Bark scale of subjective pitch (see the upper picture): the pixels in the sketch are allocated to those keys on either or both organs, the Bark pitches of which are the closest. The building, graphically rescaled to the MIDI-scale (see the lower drawing), now provides the first 97 chords, initially filtered by a horn shape centred on pitch no.68 = A-flat, the only note common in pitch to both organs. Starting with this pitch, the range gradually widens to large microtonal clusters engendered by the central Gothic window.

Footnote: *Farbtopf* (2004)

This video work (the title means “paint can”), yet in progress, converts the red-green-blue components of the pixels in a coloured picture into an electroacoustic sound-track. The source material is six equally short audio files containing the German words *rot* (=red), *grün* (=green) and *blau* (=blue) as spoken colour by colour by the Swiss performance artists Valerian Maly and Klara Schillinger, who have involved numerous names of colours in their work and thus provided the inspiration for this piece. The picture is scanned from top to bottom; the number of samples in each sound file divided by the pixel height of the picture gives the number of successive samples allocated to each successive row of pixels. The X-axis position of a pixel determines the relative amplitude of the samples taken from Mr Maly’s voice for the left and Ms Schillinger’s for the right channel. Thus a perfectly red picture results in both voices saying “*rot*”. A picture of mixed colours results in a mixed rendition of all three colour-names, the male voice at left and the female at right. The technique can be extended to form a running sound-track out of a film. It could also be reversed by converting the amplitudes of a six-channel sound mix into a running strip of colour.