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Signs (1969) by Ton Bruynèl
A signal to analysts of electro-acoustic music[1]

Far too few scores of electronic pieces have been published. This hinders the analysis of electronic music. This paper discusses the most common types of score notation for electronic music. As an excellent example, the score of *Signs* (1969) for wind quintet and tape by Ton Bruynèl is analysed. The notation of *Signs* gives insight in Ton Bruynèl's working methods: serial composition methods can be found together with statistical experiments. The electronic sounds were developed by means of 'musique concrète' techniques. The score shows also evidence of the subjective taste of the composer in his selection of fragments from the precomposed material.

Introduction

It is not easy to analyse electro-acoustic music, partly because composers rarely publish scores of their studio pieces. Many tape pieces – as they are called, even in the CD era – are the result of a very large variety of manipulations with sounds and with sound-combinations mixed into phrases. The resultant tapes are so complex that they cannot be described in the 'pitch versus time grid' of the traditional score.[2]

Of course, there exist several types of scores that can shed light on the construction of a work:[3]

a) The – subjective – 'Hörpartitur', such as the interpretation of Ligeti's *Artikulation*, but this score has not been produced by the composer himself. It is therefore not the work itself, but already an analysis.

1 This paper was read at the Fourth European Music Analysis Conference, Rotterdam, October 22, 1999.

2 Especially pitches or resonances beyond our chromatic system, or ambiguous 'noise-tones', together with very slow fades or layered non-rational rhythms resist notation.

3 The 'sonograms' described by Cogan (Robert Cogan, *New images of musical sound*, Londen 1984, see Bibliography) can also provide a better insight into the structure of a piece. However, the drawback of the sonogram is that it presents a sound spectrum in a linear frequency scale. This is very convenient for tracking the partials in a single sound, but it is very problematic for the analysis of a complex piece of music (in our ears and brains, the frequencies are appreciated as elements of a logarithmic scale: we hear ratios instead of differences between numbers of cycles per second).
My own experiments with translating the sonogram into a logarithmic frequency scale proved to be promising: relationships between sounds could be observed more easily. I believe that even more musically relevant information can be traced by investigating more contemporary methods of sound-to-image translation such as the 'wavelet analysis' (Curtis Roads, *The computer music tutorial*, Cambridge, Mass. 1996, pp. 581-589). Of course, this type of artificial notation can serve analysis, but not *everything* that is audible can actually be seen in those such representations.

b) The 'Hörpartitur' by the composer. In this way the composer opens up his music for future analysis, education and concert interpretation (sound diffusion based on the score).[4]
c) A somewhat different situation is found for pieces combining recorded material with a notated live performance on acoustical instruments. In such cases the instrumental score can be analyzed, so to give at least some clues about the structure of the whole piece.[5]
d) Only few scores exist in which the composer notated the process of producing the sounds and the relationships between the individual sounds of the piece.[6]

This paper focusses on the score of *Signs* (1969) for wind quintet and tape by Ton Bruynèl[7] and the painter Gérard Leonard van den Eerenbeemt. This 11'45" piece shows a combination of almost all types of notation discussed above. The most striking part of this score is the 'Hörpartitur', a subjective 'analysis' of the tape drawn by the painter alone. The drawing is completed with an instrumental part and a detailed report of the production process of the sounds and their splicing into the finished tape.

I intend to show that the splicing of the sounds and their production methods can actually be heard. That is, we can trace the relationships between electronic sounds, and we can determine the influence of both serial and statistical methods to produce larger sound structures.

By means of the information in the score of *Signs*, it should be possible to formalize the structural principles of the piece and its methods of sound synthesis for use in the contemporary electronic music studio.

Signs (1969) for wind quintet and soundtracks

In Ton Bruynèl's score of *Signs*, five layers can be distinguished (see Example 1):[8]
Layer 1: The parts for the wind quintet are notated conventionally, albeit with special symbols to indicate non-traditional rhythms and sounds, and with improvisational sections based on prescribed musical material.

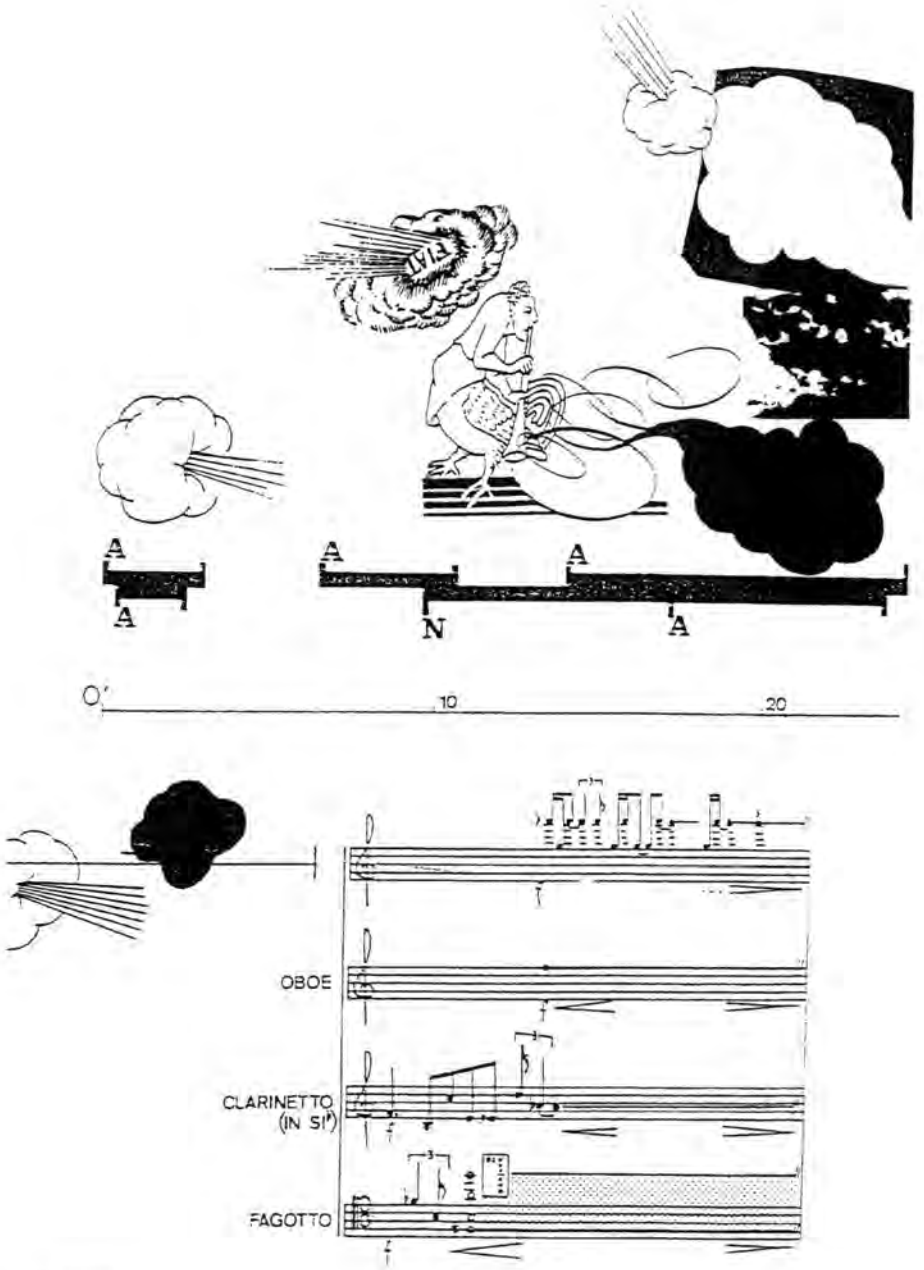
4 The Dutch pioneer Jan Boerman is a good example of a composer who found his own way to notate his electronic music, based on his working sketches.

5 In many instances, a conventional score for instruments is combined with a graphical part, which depicts the tape to guide the performers (the most famous example is the 'performance score' of *Kontakte* by K.H. Stockhausen). This drawing of the tape sounds on top of the score forms again a 'Hörpartitur' as in b).

6 Well known are the 'realization scores' of Stockhausen's *Kontakte* and G.M. Koenig's *Essay*. Especially the scores of Koenig invite musicologists and composers to realize the work again. Recently it was shown that the resulting re-interpretations based on Koenig's score reproduce the same work, just as in acoustical music practice.

7 The Dutch composer Ton Bruynèl (1934 Utrecht-1998 Mailly) is recognized as one of the main pioneers of electro-acoustic music in the Netherlands. He specialized in the combination of live instrumental music and tape. In 1957 he founded the first Dutch private electronic music studio in the city of Utrecht. His example was followed by the influential pioneers Dick Raaymakers and Jan Boerman in 1963. Ton Bruynèl was professor of electronic composition at the Conservatory of Utrecht. In his works he showed a strong attraction towards the visual arts and poetry.

8 All examples © MGN/Donemus 1995. See Sources at the end of this article.



Example 1
Signs, score p. 1.

Layer 2: A visualization of the tape has been drawn by the Dutch painter Gérard Leonard van den Eerenbeemt, not only as a guide for the players but also as a work of art.
Layer 3: On two lines, the exact mix and splicing of the tape layers is indicated by means of an alphabetical coding.
Layer 4: The layers 1, 2 and 3 are placed around a strict timeline to enable synchronization with the fixed timing of the tape by means of a stopwatch.
Layer 5: At the end of the score, several pages describe how the alphabetically coded sounds were produced (see Examples 2 and 3).

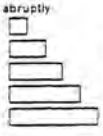
Production techniques: M

Each of the five wind instruments was separately recorded on tape in five sound-forms.

These sound-forms are notated graphically on millimetre paper as follows:

I begin abruptly and diminuendo
II begin and end abruptly
III crescendo and diminuendo
IV crescendo and end abruptly
V begin abruptly, diminuendo, crescendo, end abruptly

The five sound-forms are divided into five time units:



1 second
2 second
3 second
4 second
5 second

Five degrees of intensity pp-p-mf-f-ff

Five rests always separate the sound-forms:

1 second
2 second
3 second
4 second
5 second

Each horizontal square in the diagram indicates 1 second.

Each row of five forms, in five time units, in five degrees of intensity and five tones, is played by one instrument.

Five of these rows, one under the other, form one structure unit.

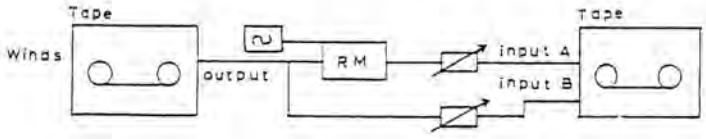
Five structures form one system.

There are five systems.

Each system played by the five wind instruments lasts 2'30".

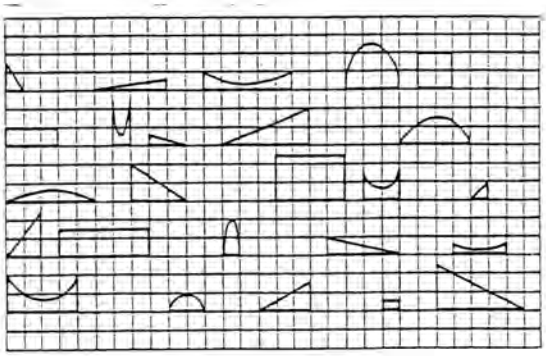
The systems, always formed from 5 structures played by 5 instruments, are examined as to their sum- and difference-tones by means of a ring modulator, multiplier type.

At each of the selected tones from the wind instruments a (control) sine tone selected according to the product by ear.



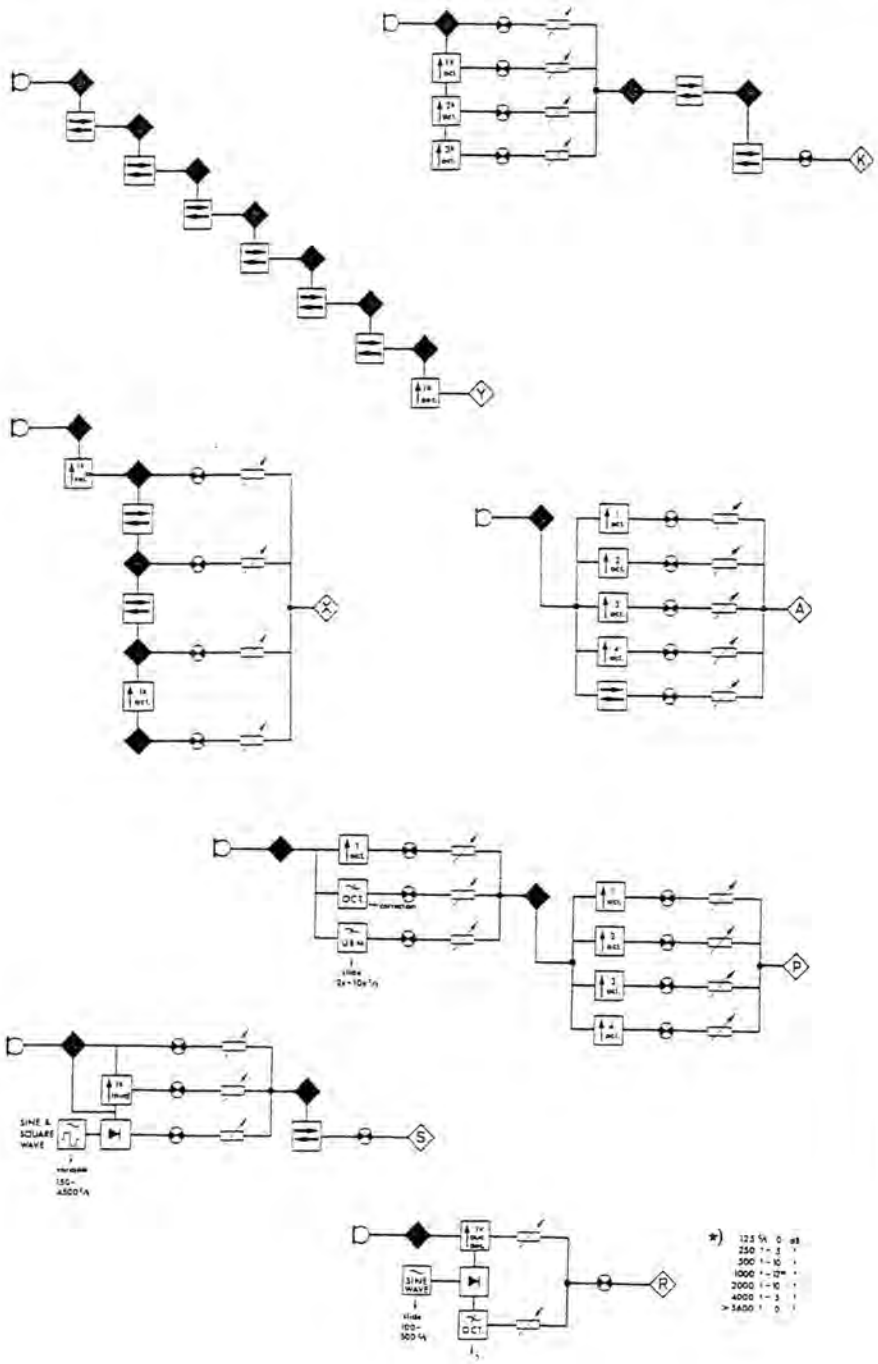
Tables System I

Form	Duration	Dynamics	Rest
14532	14532	31254	42315
25143	31254	25143	31254
31254	53421	14532	25143
42315	25143	53421	14532
53421	42315	42315	53421
51342	51342	12453	12453
12453	23514	51342	51342
23514	45231	45231	45231
34125	12453	34125	34125
45213	34125	23514	23514
32415	32415	32415	21354
43521	54132	21354	15243
54132	21354	15243	54132
15243	43521	54132	43521
21354	15243	43521	32415
24153	24153	13542	41325
35214	41325	52431	35214
41325	13542	41325	24153
52431	35214	35214	13542
13542	52431	24153	52431
41532	41532	24315	41532
52143	13254	13254	35421
13254	35421	52143	24315
24315	52143	41532	13254
35421	24315	35421	52143



Example 2

Signs, score p. IV: Production Techniques M.

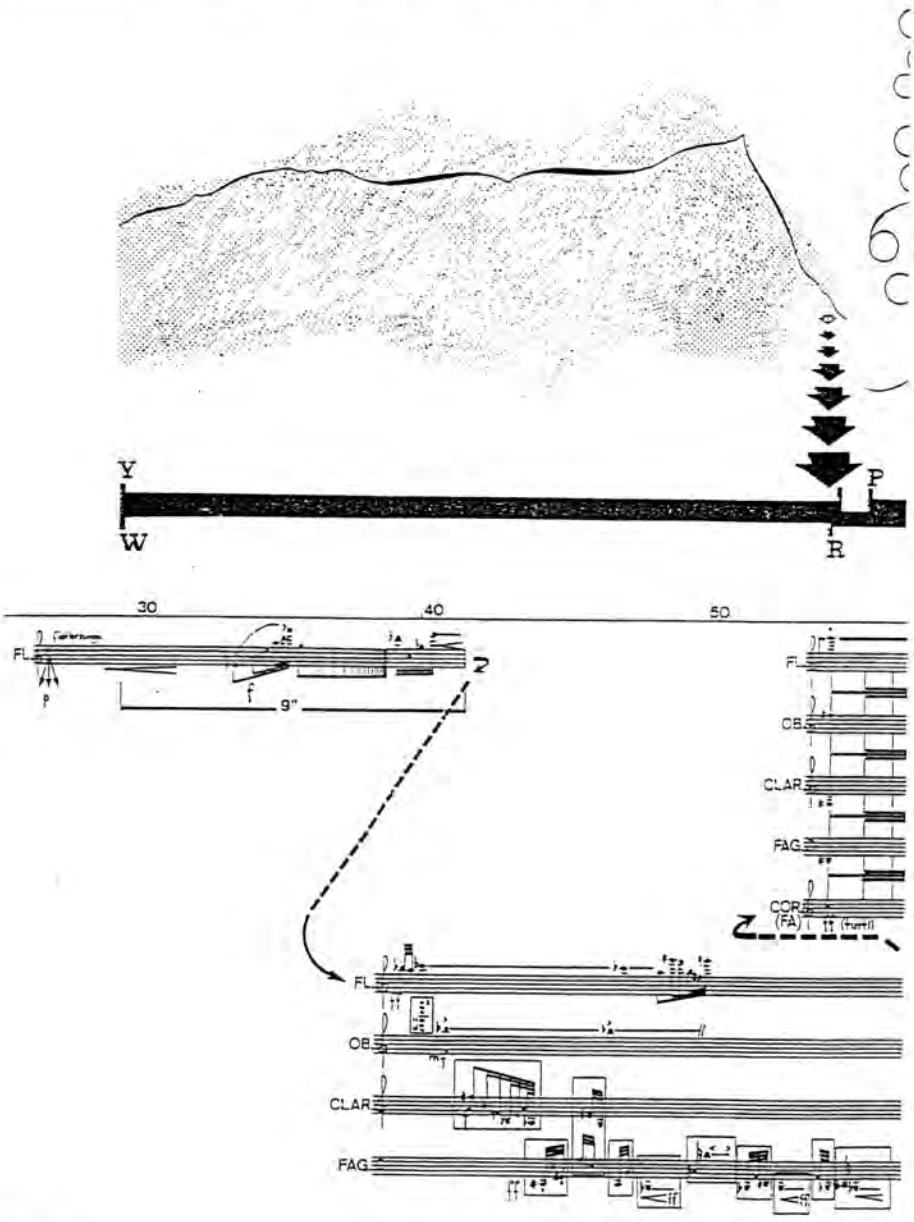


Example 3
Signs, score p. VIII.

The wind-quintet section, Layer 1

Pitch

The writing for the quintet is highly chromatic. Dissonant intervals, such as major sevenths and minor ninths, predominate in the instrumental lines. Augmented fourths and perfect fifths are frequently used to bridge the large intervals by means of a pitch halfway. Minor and major seconds, sometimes reached by a glissando, create less melodic tension. In isorhythmic harmonies, the large intervals can add up to a five-part chromatic chord in five different octaves, for instance, g^3-$f\sharp^2$-f^1-e-$D\sharp$, at 1'53" (Example 4).[9]



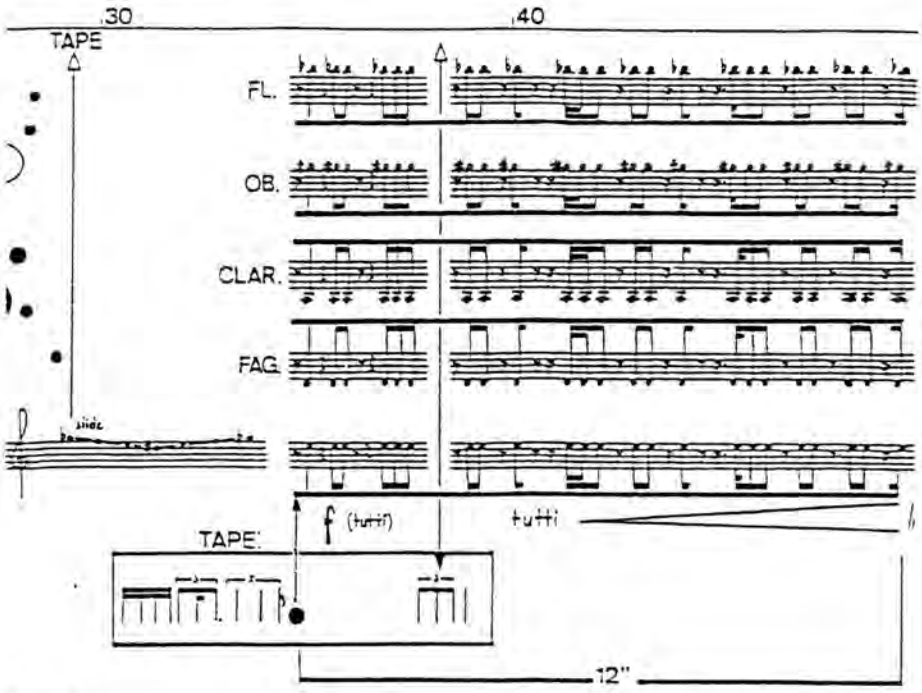
Example 4
Signs, score p. 2.

9 Instead of the augmented fourths and perfect fifths, other intervals have been used sparingly, to bridge the ninths and sevenths, or to complete the chromatic material (pp. 12-13 of the score).

Certain pitch classes or melodic figures are repeated at will, making some pitches more important and easier to recognize than others (see Example 1, flute; Example 4, bassoon). This might suggest that Bruynèl was influenced, for instance, rather by Varèse's compositions than by early strict serial works.

Rhythm

The notation of the rhythm suggests a certain freedom within the strict timing of the tape recorder, but the occasional exact collisions between taped sounds and the quintet are marked by arrows in the visualization score. Any note longer than a quarter note is coded with a line after the note, its length determining the duration of the note. Indeterminacy of the start of certain fragments is indicated by three diverging arrows (all notation forms can be found in Example 4). The use of a rhythmic notation that avoids any pulse is contrasted with sections of strict 'bouncing' rythms by all instruments, and even the tape (see Example 5).



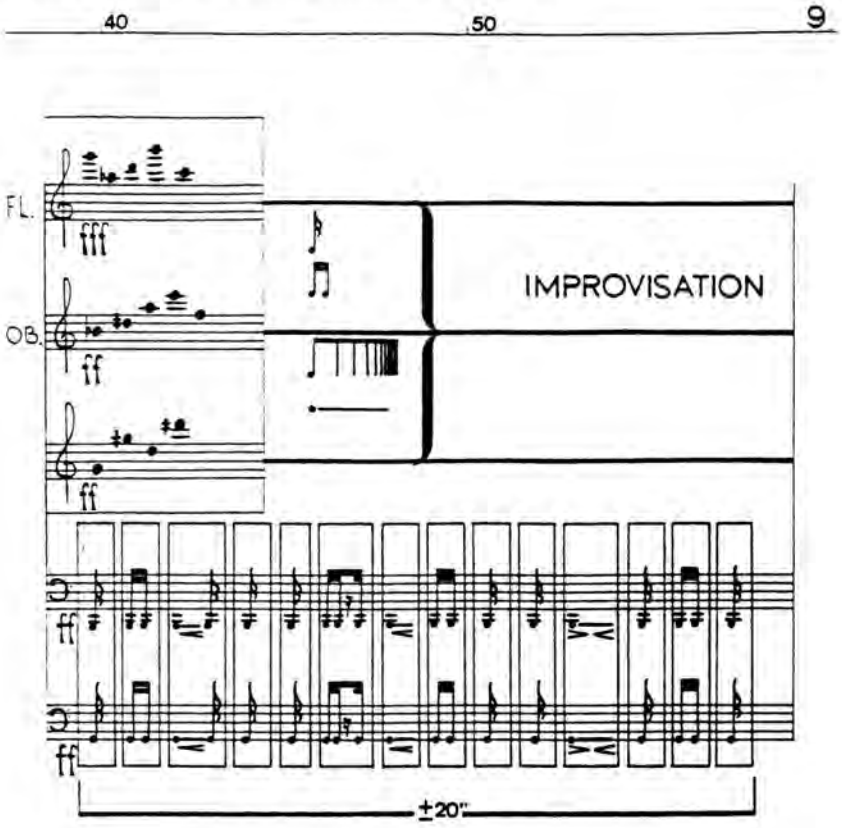
Example 5
Signs, score p. 15.

Non-traditional sounds

The piece starts with the sound of warming up the flute by blowing straight into the embouchure hole. This action is visualized by a small 'cloud' in the style of a comic (see Example 1). Circular signs describe instrumental key clicks (e.g. p. 12). A simplified drawing of a reed represents blowing glissandi on the reed, while it is disconnected from the body of the instrument (page 21). The warming-up sound, the key clicks and the reed whistling are also used extensively in the electronic music on tape. The live production of the warming-up sound and of the disconnected-reed glissando by the quintet is combined with electronic sounds derived from the same extended techniques (see Example 1).

Nowadays, multiphonics are notated in a standardized way, which includes the desired resultant pitches, but in *this* score all the pitches have been embedded in a shaded area, to visualize the ambiguous character of the sounds (see Example 1). The live multiphonics form a bridge between the electronic development of the instrumental timbres and the players: the 'ring-modulated' woodwind sounds on the tape have the same characteristic 'sum and difference tones' as the multiphonics on stage.

Example 6 shows the way in which material for an improvisation was notated.[10] Pages 18 and 20 show the jesting indication of a completely free improvisation (an open door suggests that the composer leaves the composition for 10 seconds, a magician's hat identifies improvisation as a compositional magic trick).



Example 6
Signs, score p. 17.

10 The flute, the oboe and the clarinet each have four to five pitches to play with, all fourteen pitches together use the complete chromatic scale, with C and F used twice. Bassoon and horn have fixed pichtes: B1 for the bassoon and C for the horn. All five instruments may choose from a limited number of rhythmic figures at will.

The visualization section, Layer 2

The Drawing

The visualization[11] by an informed listener, the painter Van den Eerenbeemt, can give some insight into what the electronic sounds meant for him. It can be seen that he reacted to the tape not only in an abstract way (p. 21), but sometimes even in a surrealistic fashion (pp. 11-12). He also associated some passages with the worlds of science (p. 3), or of musical instruments (p. 7). In the early years of 'musique moncrète' and serial 'elektronische Musik', much effort was put in avoiding any associative aspects of the sounds:[12] this score – made in 1969, already twenty years later – suggests an indifference to this aesthetic viewpoint.

Techniques

Van den Eerenbeemt combined collage techniques – using existing material – with original drawings. He also made a clear distinction between sounds drawn as separate objects (see Example 1) and sounds or passages drawn as visual textures (see Example 4).

On several pages, the working methods of the painter correspond exactly with studio techniques employed by the composer. As an example, we can compare the layering of several copies of a sound on tape to form an impressive mass of sound[13] with the image of p. 18, where many copies of a clarinet picture form a larger shape.

The mix and edit section, Layer 3

The exact splicings on the two tape layers are indicated by an alphabetical coding on two lines. This shows the method Bruynèl used for the ordering of the electronic sounds. First he created all the sound material (to be described in Layer 5), and next he distributed the selected fragments by means of common editing techniques, such as cutting and splicing on two tape recorders.[14]

The timeline section, Layer 4

The layers 1, 2 and 3 are placed above or below a strict timeline to synchronize them with the fixed timing of the tape.[15]

11 Because of the visualization of the electronic music by Van den Eerenbeemt, the complete score was exhibited in and published by the Stedelijk Museum of Amsterdam. In the original publication, the pages could be glued together to form one long paper with a continuous drawing. As seen above in the discussion about Non-traditional sounds (Layer 1), visual art was sometimes used in the area for the live quintet as well.
It is interesting to note that the painter made his drawings in Ton Bruynèl's private studio, listening to the tape over and over again. Bruynèl and Van den Eerenbeemt collaborated before on the experimental film *Freem* in 1965, so they must have been familiar with each other's work.

12 Peter Manning, *Electronic and computer music*, New York 1985, p.24.

13 By means of 'multitracking' or 'sound on sound', or by a system of tape delays.

14 Silence between the sound fragments (blank passages on at least one of the lines) was produced by splicing 'white' tape of the exact length into the tapes. When the editing was finished, the complete piece – still existing on two tape recorders – had to be mixed onto a third recorder. From this master tape, new copies for performances could be made.

15 In several points dense textures of the wind quintet do not fit below this rigid timeline; in those cases extra space is created by a system of arrows and extra staves (see Example 4).

Because of the timeline, the splicings in the mix-and-edit layer can be measured in seconds. This shows us that the construction of the tape was guided by the Fibonacci numbers 3, 4, 7, 11, 18, 29, etc.[16]

The combination of layers 1, 2, 3 and 4: Form

Looking at the tape visualizations, the timeline and the quintet score together, we can get an overview of the form of the piece. In my opinion, the first two minutes can be seen as the blueprint of the complete piece.

Aa) *Signs* starts quietly with the warming-up-sound, but develops in 20 seconds into a dense structure.

Ab) At 0'29", a soft electronic texture accompanies solo or polyphonic lines.

Ac) At 0'54", a strict pulsating rhythm builds up in all five instruments; the tape becomes fragmentary and multi-layered.

B) After 2'00", the piece seems to restart with the warming-up sound. This time it develops at a slower pace and with sparse, continuous electronic sounds, until 5'53".[17]

C) At 6'02" the build-up to the final climax begins. The tape becomes fragmentary and dense again. The quintet re-introduces the frantic pulsating rhythm, which develops into an alternation of chaotic improvisational sections and strict pulsating parts. This results in a loud, one minute climax, consisting of a screaming texture.[18] At 11'45" the piece ends suddenly, even more abruptly than the first section did at 2 minutes.

The overall structure of *Signs*, with:

A) Development with stop,

B) Slow section,

C) Dense pulsating section with sudden stop,

can also be recognized in the structure AaAbAc of the opening section.

The sound production section, Layer 5

Material M

At the end of the score, seperate pages describe how the alphabetically coded sounds of the mix-and-edit layer were produced. Material M must be seen as the core sound material: the description in the score is very detailed, and all five woodwinds have contributed to its production.

A completely serial method, based on the permutation of the numbers 1 to 5, provided the values for duration, rests, dynamics, and dynamic 'envelope'.[19] The number 5 in this serial system links the number of wind players to the organisation of the sounds.

16 Around the Fibonacci numbers – interpreted as seconds – other overlapping sounds can coexist, that are 1, 2 or 3 seconds early or late.

17 In this section the quintet plays truly polyphonic lines alternating with slow iso-rhythmic chordal sections. The fast pulsating rhythms play no part in this piece, but the chordal passages can be regarded as highly slowed down versions.

18 This texture is based on blowing glissandos on the disconnected reeds (both live and in the recorded sounds).

19 The numbers 1 to 5 are used as seconds for the values of duration and rests. For the dynamics the five values are translated as *pp*, *p*, *mf*, *f*, and *ff*. The possible five dynamic envelopes are (1): abrupt start and fade-out (2): abrupt start and end (3): fade-in and fade-out (4): fade-in and abrupt end (5): abrupt start, decrescendo, crescendo to abrupt end. Envelope 5) can be understood as the mix of (1) and (4).

The pitch parameter of the instruments was not controlled by the system.[20]

The five instruments were recorded on mono tape directly, each instrument playing a seperate sequence. The five mono tapes with the wind instruments were replayed and mixed directly onto one track of a new stereo tape. At the same time, the sounds of the mono tapes were played through five individual ring modulators, mixed and recorded on the second track of the stereo tape. This new tape finally contained fifteen minutes of material M (see Example 2). [21]

The processing of M

Flowcharts describe the methods by which material M was processed into new material. In 1969, this must have been a tedious job. It involved, among other things, further ring modulation, equalizing and filtering, flanging (by hand!), and transposition by manipulating the tape speed. Sometimes the sound of a processed version of M itself is further processed. Thus we can see in the flowcharts, that material G is made out of M.[22] The layering of three transposed versions of G results in material T.

The use of one tape as the sound source for most of the piece created unity. Out of the same sounds, Bruynèl derived different new sounds that were all related. From the example above one could say that T is the 'child' of G and the 'grandchild' of M.[23]

The processing of additional material

The techniques used to produce variants of material M are also applied to other, more simple, sound sources. Thus material A, the material that opens the piece, was produced by recording the warming-up of the flute, whereupon a flanged version of the recording was mixed with four transposed versions[24] (see Example 3).

Selection

All the above production methods can be regarded as logical derivations of well chosen pre-recorded sound material. It may seem as if one could formalize these processes to produce the same sounds again. But in almost all flowcharts we find symbols that stand for 'selection'. This selection principle introduced the subjective taste of the composer

20 The score gives no clue to what method was used instead, but one may think of the use of a tone-row or of improvisation by the players. To investigate this it will be necessary to have access to the material tapes of the composer.

21 The pitches used for the five oscillators that controlled the five ring modulators were selected by the composer 'by ear'!

22 Bruynèl first created a flanged version of M. He transposed this flanged version 2 octaves upward by means of tape speed manipulation. He then mixed this transposition with a ring-modulated – sometimes filtered – variant of the transposition to a new tape. He finally transposed this recording another octave up, to form the definitive material G.

23 From M Bruynèl created the complex sounds D, G, H, L, N, T and W. This method of composing related sound material by 'processing what has already been processed' can also be seen as an influence from serial composition methods.

24 The sounds A, B, K, P, Q, R, S were all derived from additional material produced by the wind players. The rattling of keys and valves was used in the production of R, X and B. The screaming glissandi on the reeds and the mouthpiece of oboe, bassoon and horn were processed by modulation, transposition and flanging into S; by transposition and mixing with a square wave, S was turned into U (the square wave in U is the only synthetic timbre audible in *Signs*).

into the logical processing of the pre-recorded material: he selected only those (parts of) sounds that he thought were well suited for his piece.[25]

Material E

To produce material E, Bruynèl used a simple statistical method. He assembled a tape containing 37 fragments,[26] copied this tape four times, and distributed the copies over five (!) independent tracks, located on three tape recorders. By permuting the speeds of the recorders, the material overlapped in many ways. The improvised mixes were recorded as E. Selections of E appear in the piece during the build-up to both the first (Ac) and the final climax (C).

Flowcharts as examples

The flowcharts of *Signs* can be used to gain a better understanding of early electro-acoustic music, especially now that the technology needed for the production of electronic music is widely available. However, the youngest composers and theorists are hardly aware of the aesthetic and technological origins of this contemporary technology.

In the composition studio of the Rotterdams Conservatorium, the means to translate the algorithms in the flowcharts of *Signs* into digital equipment are available in the form of versatile programs to produce and process sounds. Moreover, thanks to the very kind cooperation of the heirs of Ton Bruynèl, the composition studio offers the possibility for composers to work with the original private studio of Bruynèl.[27]

Conclusion

The score of *Signs* gives insight in TonBruynèl's working methods: serial composition methods can be found together with statistical experiments. The electronic sounds were developed by means of musique concrète techniques. The tape splicing is guided by the Fibonacci series.

The score shows evidence of the subjective taste of the composer in his selection of fragments from his precomposed material. This makes it impossible to realize the very same piece again on the basis of the score, but it should be possible to recreate the same sound-world, even using contemporary studio equipment.

It is important that more composers of electronic music make scores of their compositions and document their working methods, maybe in a digital format. This will help music theorists and composers to gain more insight into electronic music.

25 Moreover, the improvised character of processes like mixing and filtering resists complete formalization (see the flowchart of Q as an extreme example).

26 Some of them were simple recordings of the instruments, others were short selections from the processed materials described above.

27 In Bruynèl's studio, all of the above apparatus – some of it dating back to 1957 – together with more contemporary equipment, is available for research into sound and composition. Direct links of Ton Bruynèl's studio with the recording studio, the computer-based studio, as well as with the concert-hall create a seamless integration within the conservatory.

Sources

Signs (1969) for wind quintet and soundtracks by TonBruynèl, visualized by Gérard Leonard van den Eerenbeemt. Het Stedelijk Museum, Amsterdam 1969 (including an LP with the tape part and a recorded performance). Reprint MGN/Donemus, Amsterdam 1995 (including a CD with the tape part and a recorded performance).

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