INSTITUTE OF SONOLOGY

Royal Conservatoire The Hague

Waveforms

Programming and Music 2

http://www.bjarni-gunnarsson.net

Composing Sound

Composing Sound

Composing sound instead of composing <u>with</u> sound.

Attitudes concerned with creating sound through the manipulation of <u>individual samples</u>.

Attempts in unifying **micro** and **macroform** of composition.

Sometimes this results in a <u>tight relationship</u> between *frequency* and *time*.

Composing Form, Composing Material.

Xenakis

In the 1960s, Xenakis was using *probabilities* and *computers* to compose instrumental music. He also imagined the potential of using **stochastic methods** for **sound synthesis**.

His ideas are described in the chapter *"New Proposals in Microsound Structure"* (Formalized Music, 1971).

He <u>opposes</u> synthesis techniques based on Fourier analysis and trigonometric functions .

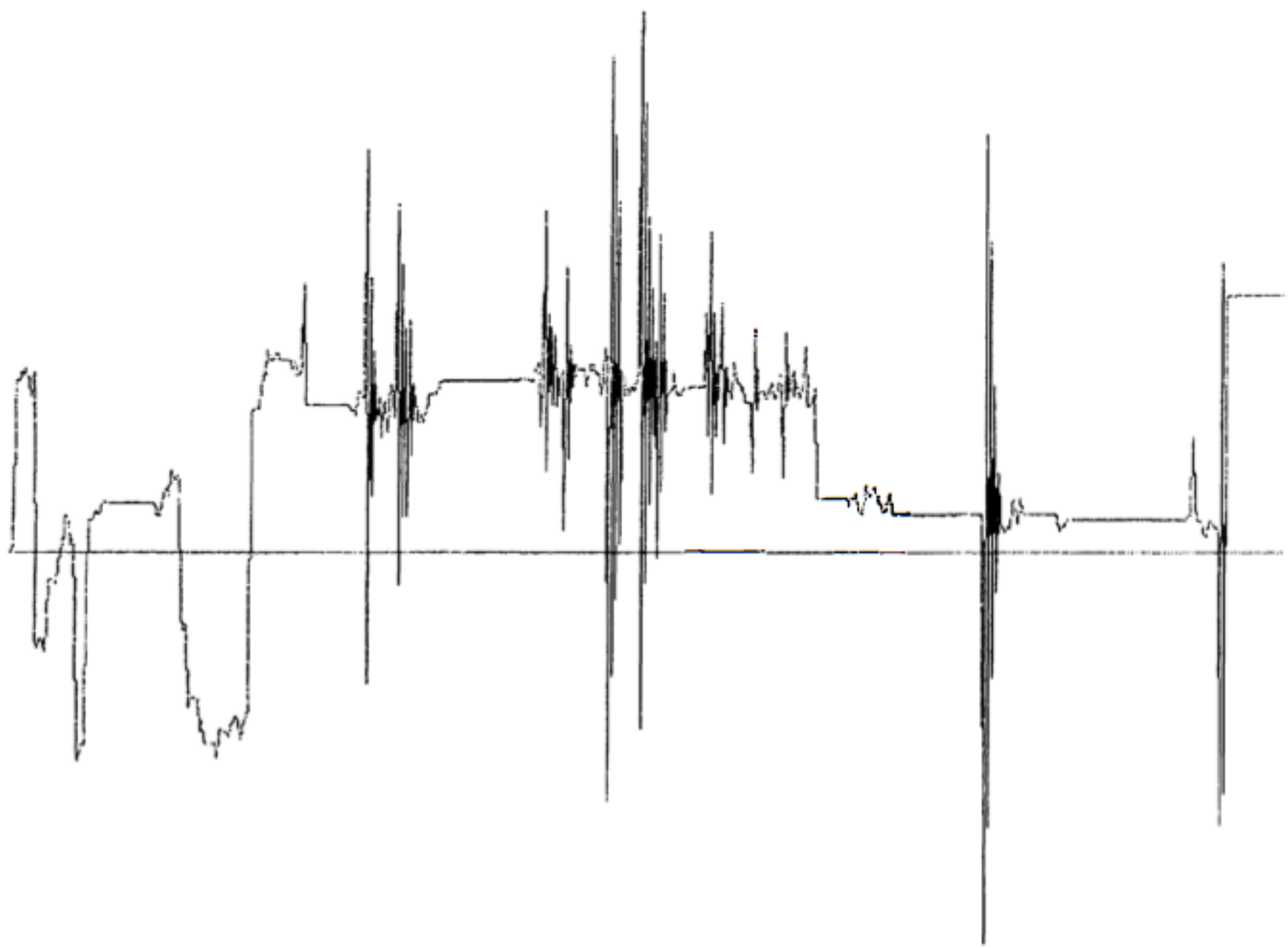
He <u>proposes</u> stochastic methods as means to produce sounds with complex transients.

Xenakis

"Instead of starting from the unit element concept and its tireless iteration and from the increasing irregular superposition of such iterated unit elements, we can start from a disorder concept and then introduce means that would increase or reduce it. This is like saying that we take the inverse road : We do not wish to construct a complex sound edifice by using discontinuous unit elements (bricks = sine or other functions); we wish to construct sounds with continuous variations that are not made out of unit elements. This method would use stochastic variations of the sound pressure directly."

Xenakis, Formalized Music

Xenakis



Exponential x Cauchy Densities with Barriers and Randomized Time (***Formalized Music***)

Xenakis

Used stochastic synthesis for the first time in **Polytope de Cluny** (1972).

In **La Légende d'Eer** (1977) Xenakis uses a new technique Dynamic Stochastic Synthesis which is based on the ideas proposed in *"New proposals …"*.

It was based on **breakpoint** sets, **random walks** and **barriers**.

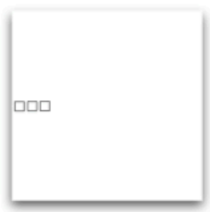
Xenakis then only returns to the idea in the late 1980s when he writes the **GENDY** (and **PARAG**) programs.

He composes the pieces **GENDY3** (1991) and **S.709** (1994).

Xenakis

Dynamic Stochastic Synthesis (1977): Method

1. Select the number of breakpoints for the waveform. For example: 3



2. Select the waveform's minimum and maximum frequencies and convert them to duration in number of samples. For example:
   368-735 Hertz = 120-60 samples

3. Divide the minimum and maximum number of samples by the number of breakpoints:
   60/3 = 20
   120/3 = 40
   These values are the barriers for the duration random walk of each breakpoint.

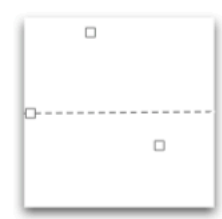
4. For the continual generation of steps for all the duration random walks: select a probability distribution, its parameters and the ± number that will be the minimum and maximum size for these steps.

5. An initial duration is given to each breakpoint: values taken from stochastic or trigonometric functions, the minimum or the maximum duration, etc.

6. A maximum amplitude is selected and this ± value is the barrier for the amplitude random walk of each breakpoint.

7. For the continual generation of steps for all the amplitude random walks: select a probability distribution, its parameters and the ± number that will be the minimum and maximum size for these steps.

8. An initial amplitude is given to the each breakpoint: values taken from stochastic or trigonometric functions, zeroes, etc.



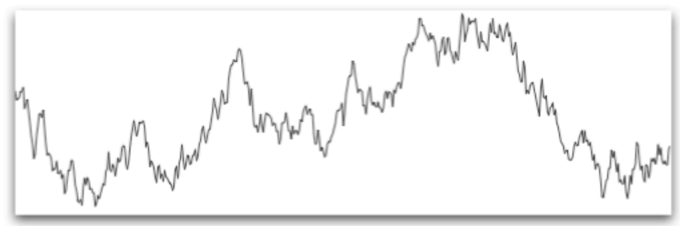
9. Breakpoints are linked by linear interpolation. At each repetition, the last breakpoint of the current waveform is connected with the first breakpoint of the next variation of the waveform.

Waveform 0 Waveform 1

from '*Stochastic Synthesis, Origins and Extensions*' by Sergio Luque

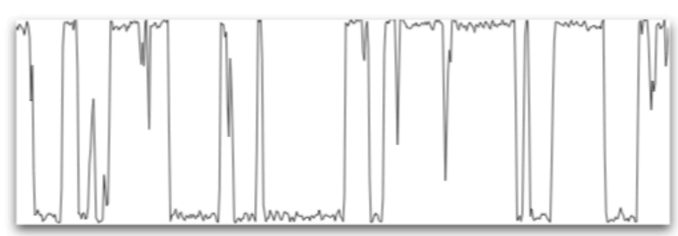
Xenakis

- A first order random walk oscillates around an equilibrium position that changes arbitrarily over time. Sudden changes in position happen when several consecutive steps in the same direction are taken or when a step with an atypical size is made.



First order random walk with two elastic barriers

- A second order random walk gravitates around one of its two barriers:
  - if the position of its primary random walk is positive, it gravitates around the upper barrier
  - if the position of its primary random walk is negative, it gravitates around the lower barrier



Second order random walk with two pairs of elastic barriers

from '*Stochastic Synthesis, Origins and Extensions*' by Sergio Luque

Iannis Xenakis - S.709 (1991)

Iannis Xenakis - S.709 (1994)

Herbert Brün

To **design processes** and discover what they will bring forward.

Starting from scratch and **composing** with **sample values** instead of translating traditional music thinking to computer languages.

Interested in social functions of the "*composer*" and the "*listener*"

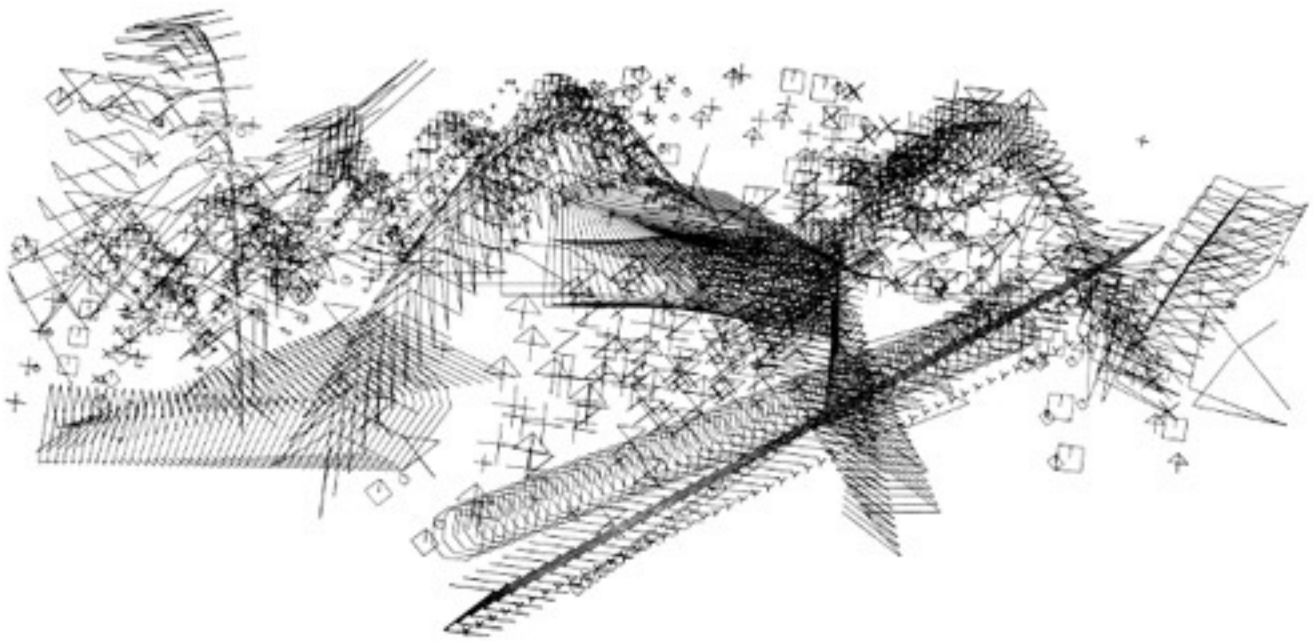
Composed works for instruments and tape as well as pure tape pieces where he composed the waveform itself using **SAWDUST** a computer program Brün created.

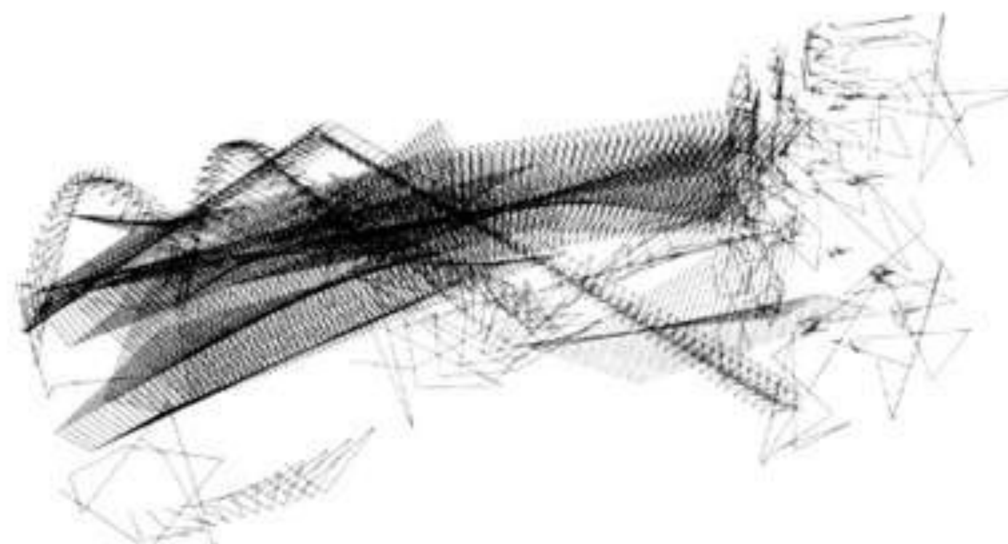
Herbert Brün

“If ever there will be a technological era worth talking about, it will be thanks to technologists and composers. By their joint efforts, extended over a prolonged period, they may contrive to emancipate thought from language sufficiently for a rehabilitation of both, and continuing from that, introduce an era for mankind where every thought has its language, and where all people have at their disposal a device that will respond to each person's input according to the language stipulated by that person… The difference between technology and composition will dwindle to an insignificant degree of a nuance; whereas the difference between nuances of thought will acquire significant proportions, worthy of the discriminating potentials of the human mind.”

Herbert Brün (Technology and the Composer)

Herbert Brün





Computer generated graphics.

SAWDUST

Necessary to specify **elements** and **list** of **elements**.

An element consists of an **amplitude** and **duration** (in samples).

Links are created which consists of a **sequence** of **elements** and the **number** of **times** it should be played.

Transformations are made to the links using the operations:
* **Mingle** (repeat links or collections of links)
* **Merge** (combine or alternate link values)
* **Vary** (transform one link to another one)

"If it can be shown that there exist significant musical ideas which require compositional thinking where not the sound but the waveform is the basic element and standard, then it can also be shown how the computer not only helps the composer to the fulfillment of up to now unfulfillable desires, but actually assists the composer in generating desires he never knew before."

Koenig

Extending ideas from **PR1** and **PR2**, Koenig created **SSP** for sound synthesis in the early 1970s.

The first working version was completed by Paul Berg in 1977 and operated in real-time.

SSP can be related to serialism through the desire to **unify macro** and **microtime** by using the same organization principles on multiple levels.

Represents a **rule-based attitude** to composition: *Given the rules, find the music*.

SSP

“Serialism is not just about the ‘series’ but also about quantization and differentiation.”

“Both serial and electronic music are characterized by a high degree of formalization and mechanization.”

“I experience form as a process as soon as I start working in the studio or at my desk; every bar on paper, every sound on tape changes its formal function every time I look at it, like the light in a landscape under scudding clouds.”

SSP

Amplitude values and **time values** ware the raw material to work with.

4096 amplitude values possible and time was specified in microseconds with 38 being the minimum time value.

Selection principles and **permutations** are applied to the amplitude and time values to generate an "*sound segments*". Another selection is then performed to link the segments.

Selections: **sequence, alea, series, ratio, group, tendency, copy.**

Permutations: **list, select, segment, permutation.**

SSP

“My sound synthesis program SSP endeavours to transfer the generating principles of musical form to sound synthesis, and hence has common links with electronic music which, particularly in its developmental phase in Cologne, stressed the inseparable unity of sound and sound structure. My aim was to apply the idea of a form-generating principle, as can be studied in Project 1 and Project 2, to the genesis of sound; the changing sound-field should represent the development of the form "directly", as it were, without being communicated by musicians and traditional instruments. The renunciation of this form of communication entails the renunciation of instrumental sounds, since their imitation would have been distracting.”

Koenig, Programmed Music

ASP

Paul Berg developed a suite of programs (about 22 different ones) called **ASP** (*Automated Sound Programs*) that ran in real-time and generated sound based on random numbers, comparisons and arithmetics.

An **initial condition** was set and the programs could **start** and **stop**. A program could run forever.

The smoothing filter attached to the DAC was manually disconnected since it was not part of the ASP concept.

A **monitor program** existed that could trigger each of the ASP programs.

ASP

A **digital approach** to music with the computer.

Instead of using the computer to aid due to its fast number crunching abilities more interesting cases can be imagined:

“To hear that which without the computer could not be heard;
to think that which without the computer could not be thought;
to learn that which without the computer could not be learned”

Paul Berg

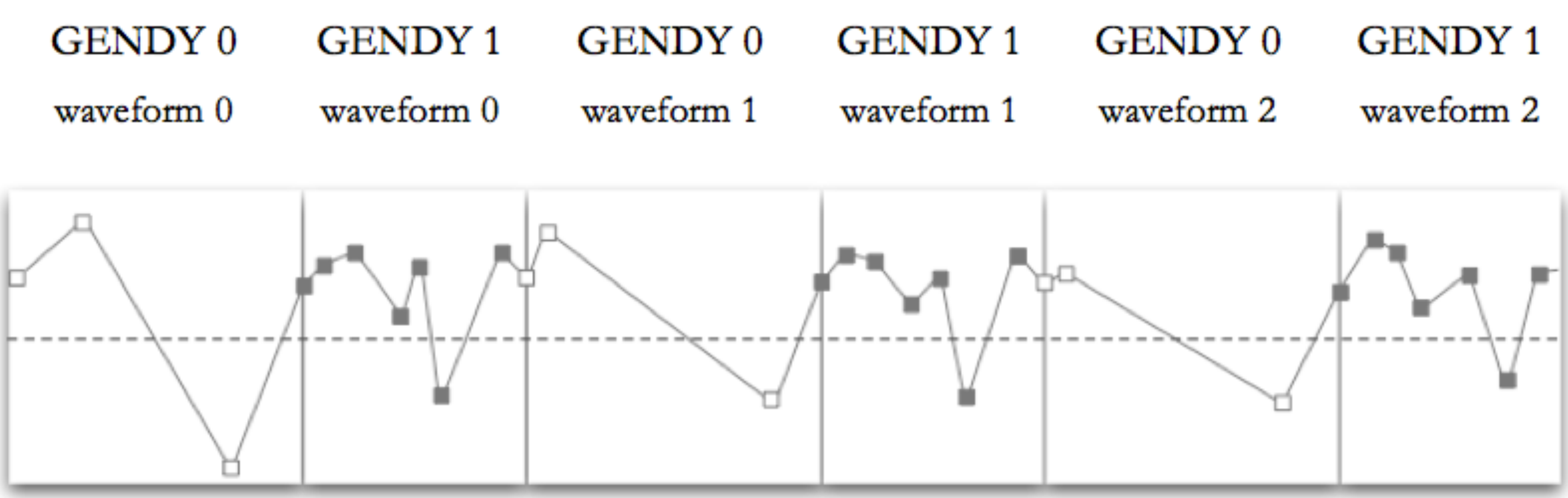
Computerstudio with PDP-15 computer

Paul Berg - Merriweather´s guide to plants and people (1975)

Sergio Luque

Sergio Luque has proposed extensions to Xenakis' dynamic stochastic synthesis Model: ***Stochastic Concatenation of Dynamic Stochastic Synthesis.***

His technique constructs a waveform by ***concatenating*** the waveforms of a set of GENDYs outputs.



Agostino Di Scipio

Holds that **microstructural timbre composition** escapes the traditional separation of sound material and musical form.

Has used iterated **nonlinear functions** to control granular synthesis and later to generate waveforms (Functional Iterated Synthesis).

Inspired by noise and turbulence but has in recent years been working with environmental feedback loops (Audible Ecosystems and room-dependent sound installations).

Di Scipio

"I intimated that design processes addressing such low scales of time in the musical structure may be conceived of as strategies of microstructural time modeling of sound. Such strategies imply some model or knowledge of how macro-level properties of musical structure can emerge from micro-level morphological conditions. Indeed, a true exploration must be an indeterministic, open ended experience. Of course, all creative experiences of art and music feature elements of indeterministic style of design, what Simon calls designing without goals … The uniqueness of micro-time sonic strategies lies exactly in fostering and supporting this kind of creative attitude in the context of timbre composition, hence in the possibility of a profound shift in the relationship of materials of form."

Di Scipio, Micro-time sonic design and timbre formation

Trevor Wishart

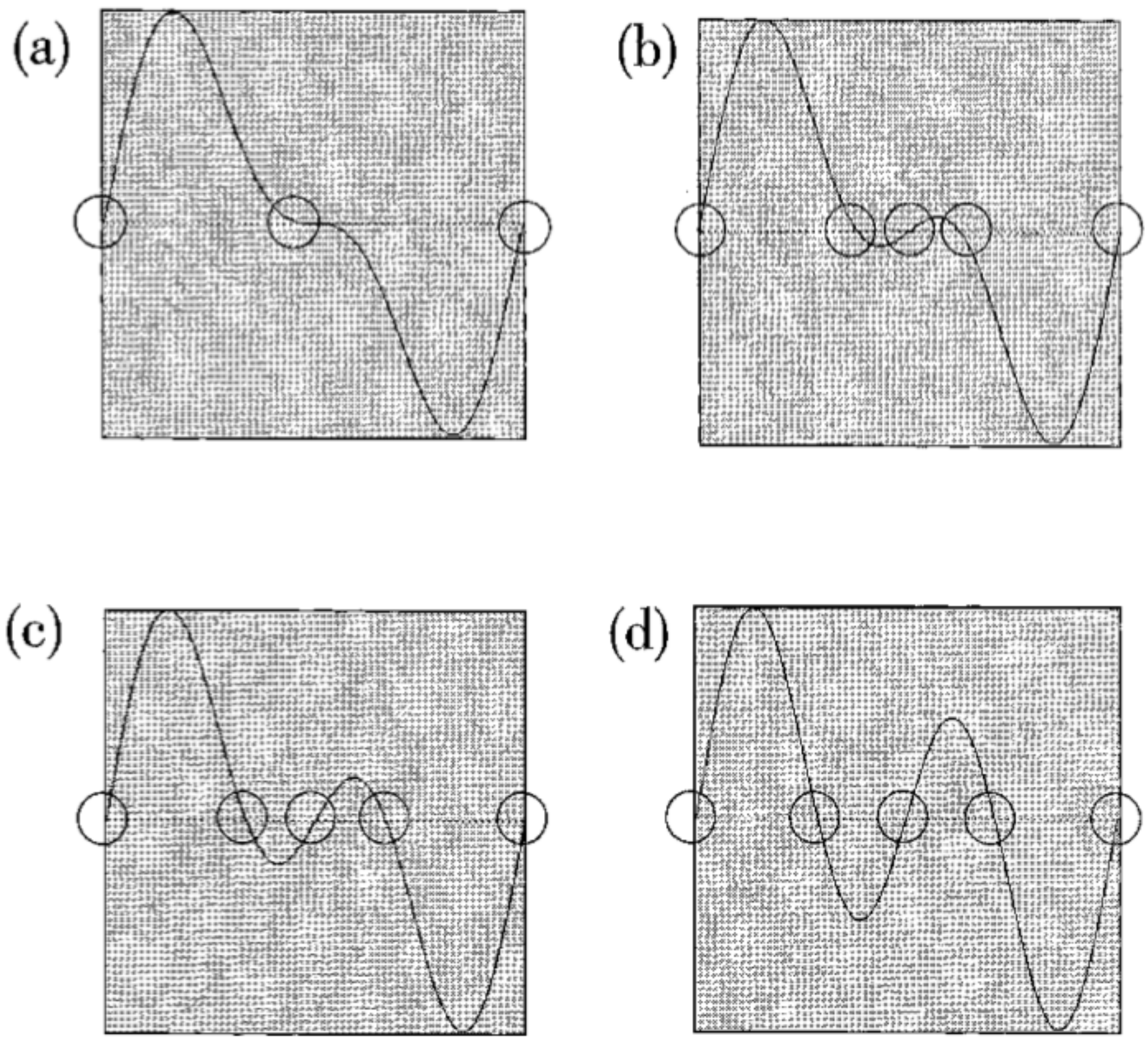
Developed **Waveset distortion** while composing Tongues of Fire (1994).

A waveset is defined as the signal between any pair of zero-crossings.

Wishart has created many transformations based on waveset distortions which by definition are signal-dependent and time-varying since the waveset boundaries are defined by the sound itself instead of by an external process.

Wishart

(a) (b) (c) (d)



Exercises

```
(
    NF(\iop, {|freq=78, mul=1.0, add=0.0|
        var noise = LFNoise1.ar(0.001).range(freq, freq + (freq * 0.1));
        var osc = SinOsc.ar([noise, noise * 1.04, noise * 1.02, noise * 1.08],0,0.2);
        var out = DFM1.ar(osc,freq*4,SinOsc.kr(0.01).range(0.92,1.05),1,0,0.005,0.7);
        HPF.ar(out, 40)
    }).play;
)

(
    NF(\dsc, {|freq = 1080|
        HPF.ar(
            BBandStop.ar(Saw.ar(LFNoise1.ar([19,12]).range(freq,freq*2), 0.2).excess(
            SinOsc.ar( [freq + 6, freq + 4, freq + 2, freq + 8])),
            LFNoise1.ar([12,14,10]).range(100,900),
            SinOsc.ar(20).range(9,11)
        ), 80)
        ;
    }).play;
)
```

```
var <>pindex, <>cindex;

initialize {
    if(pindex.isNil, { pindex = 1000 });
    if(cindex.isNil, { cindex = 2000 });
}

clearProcessSlots {
    pindex = 1000;
    (this.pindex - 1000).do{|i| this[this.pindex+i] = nil; }
}

clearOrInit {|clear=true|
    if(clear == true, { this.clearProcessSlots() }, { this.initialize() });
}

transform {|process, index|
    if(index.isNil && pindex.isNil, {
        this.initialize();
    });

    pindex = pindex + 1;
    this[pindex] = \filter -> process;
}

control {|process, index|
    var i = index;

    if(i.isNil, {
        this.initialize();
        cindex = cindex + 1;
        i = cindex;
    });

    this[i] = \pset -> process;
}
```

```
(
    NF(\depfm, {|freqMin=5, freqMax=20, mul=20, add=80, rate=0.5, modFreq=2100, index=0.3, amp=0.2|
        var trig, seq, freq;
        trig = Dust.kr(rate);
        seq = Dwhite(freqMin, freqMax, inf).midicps;
        freq = Demand.kr(trig, 0, seq);
        HPF.ar(FMOsc.ar(LFCub.kr([freq, freq/2, freq/3, freq/4], 0, mul, add),
        LFNoise1.ar(0.3).range(modFreq,modFreq*2), index) * amp, 50)
    }).play;
)
```

Exercises

1. Create a demand rate waveform that contains two different demand patterns for creating both durations and levels.

2. Implement a SynthDef with at least two or more Gendy oscillators. These should additionally be cross-modulated using binary operations.

3. Generate a buffer to read with Osc based on at least three different ways of creating random numbers.

4. Implement a pattern for reading a sample that has been analysed to wavesets. The pattern should brownian motion for its movements.

5. Experiment by creating a shape that will be used at the same time as a waveform for synthesis and an envelope for a sound object.