INSTITUTE OF SONOLOGY

Royal Conservatoire The Hague

Granularity

Programming and Music 2
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Microsound

Microsound is a term used to discuss extremely short time scales of sound and the music composed with a focus on these scales.

Granular synthesis is an example of a microsound-related activity.

Granular synthesis uses large numbers of grains to create **higher level sonorities**. The magnitude of the task requires a computer algorithm and is also well suited for implementing compositional methods.

Microsound

Perhaps the only **synthesis technique** not described as a set of equations.

An attitude, not a specific activity that involves building sounds using small **particles**: *10-100 ms.*

"Lends itself for experimentation with compositional methods, due to the relative lack of acoustic limitations ("it always sounds good whatever you do")" (**Paul Berg**)

The term **microsound** was first used by Xenakis and the synthesis method originally comes from his **artistic vision**.

Xenakis

"Events such as the collision of hail or rain with hard surfaces the song of cicadas in a summer field a political crowd of dozens or hundreds of thousands of people…It is an event of great power and beauty in its ferocity. Then the impact between the demonstrators and the enemy occurs. …Imagine, in addition, the reports of dozens of machine guns and the whistle of bullets adding their punctuations to the total disorder. The crowd is then rapidly dispersed, and after sonic and visual hell follows a detonating calm, full of despair, dust, and death."

Xenakis, Formalized Music

Di Scipio

“Most of the richness and complexity of sound afforded by this approach stems from the fact that micro-time sonic design does not implicitly prescribe any particular acoustic model: it is the implementation of a compositional micro-level strategy which determines the kind of sound behavior modelled or produced. That is, what is implemented is a model describing how quanta of acoustic energy are distributed in the time-domain, and how the temporal organisation of those innumerable elementary sonic units may result in a global auditory image.”

Di Scipio, Micro-time Sonic Design

Time Scales

For Schoenberg the smallest element of a piece is the note. With notes one can construct motives. Motives can then construct phrases which then can be used to construct themes and from those one arrives at musical compositions.

"Smaller forms may be expanded by means of external repetitions, sequences, extensions, liquidations and broadening of connectives. The number of parts may be increased by supplying codettas, episodes, etc. In such situations, derivatives of the basic motive are formulated into new thematic units."

Schoenberg, 1967

Time Scales of Music

1. **Infinite** (The ideal time span of mathematical durations)
2. **Supra** (Beyond that of an individual composition... months, years, decades)
3. **Macro** (Overall musical architecture or form, measured in minutes or hours)
4. **Meso** (Groupings of sound objects into hierarchies of phrase structures)
5. **Sound object** (A basic unit of musical structure, generalizing the traditional note)
6. **Micro** (Particles on a time scale that extends down to the threshold of perception)
7. **Sample** (The atomic level of digital audio systems)
8. **Subsample** (Fluctuations on a time scale too brief to be properly perceived)
9. **Infinitesmall** (The ideal time span of mathematical durations)

Curtis Roads, Microsound.

Macro

Top-down or bottom-up ?

The **top-down** approach considers form as a preconceived global plan where the details are completed at later stages of the the composition.

The **bottom-up** approach considers form as the result of interaction between materials, where the overall form is brought forward by lower level relationships.

For many, composition involves a tension between the top-down and bottom-up approaches.

Meso

Phrases and **local** structures.

Sequences, combinations, and transmutations that constitute musical ideas usually unfold on the **meso** level.

Give rise to sound masses, textures, and clouds of sound objects.

Sound object

The **note**, an elementary unit of composition in scores.

The term ‘**Sound object**’ originates from Pierre Schaeffer who used it to for any sound whose origin was easily identifiable.

Notes can usually be described by four main attributes. **Pitch**, **timbre**, **dynamics** and **duration**.

Involve generalization (MIDI) not always useful for discussing the ´inner-life´ of sounds or possibilities in electronic music.

Micro

Lasting from the threshold of perception up to short sound objects lies the **domain of microsound**.

Inaccessible until rather recently by using the computer, microsound offers original options for composing sounds.

Transient events happening on the micro level influence highly how we perceive sound. These do not always reach perception until they occur in masses forming collected sound-objects.

Duration

"One of the most important properties of a sound is its duration. Certain sonic processes require a sufficient duration to unfold. For example, the sweep of the cutoff frequency of a filter is most effective on a timescale greater than 100 ms. When the duration of any sound is very short (e.g., less than 20 ms), it is perceived as a transient event, regardless of its inner structure. As the duration of an event shrinks toward 1 ms, its amplitude envelope affects its spectrum more than its waveform, due to the effects of convolution."

Curtis Roads

Perception

Sounds with a very short duration must be greater in intensity then longer ones in order to be perceived equally.

Onset of one impulse rapidly succeeding another can mask the second one and all any following. This contributes to the illusion of a continuous sound.

Perception

Pitch recognition is dependent of frequency where the highest definition occurs in the **mid-range**.

It is possible to hear microevents as short as 1 ms. Such short sounds are mostly perceived as **clicks** with a distinguishable timbre, amplitude and spatial position.

Xenakis

Conceives a **granular vision** for sound composition. Came up with the term microsound in 1960.

Mentions Gabor in Formalized music but later refers to Einstein as his inspiration.

Concret PH (1958) is made from recordings of burning charcoal arranged in a dense and rich configuration with a simple macroform.

Analogique B created from granular sine-tones projected on three dimensional "**screens**" with representations for frequency, amplitude and time.

Screens

"All sound is an integration of grains, of elementary sonic particles, of sonic quanta ... all sound, even continuous musical variation, is conceived as an assemblage of a large number of elementary sounds adequately disposed in time. In the attack, body, and decline of a complex sound, thousands of pure sounds appear in a more or less short interval of time Δt..."

Formalized Music

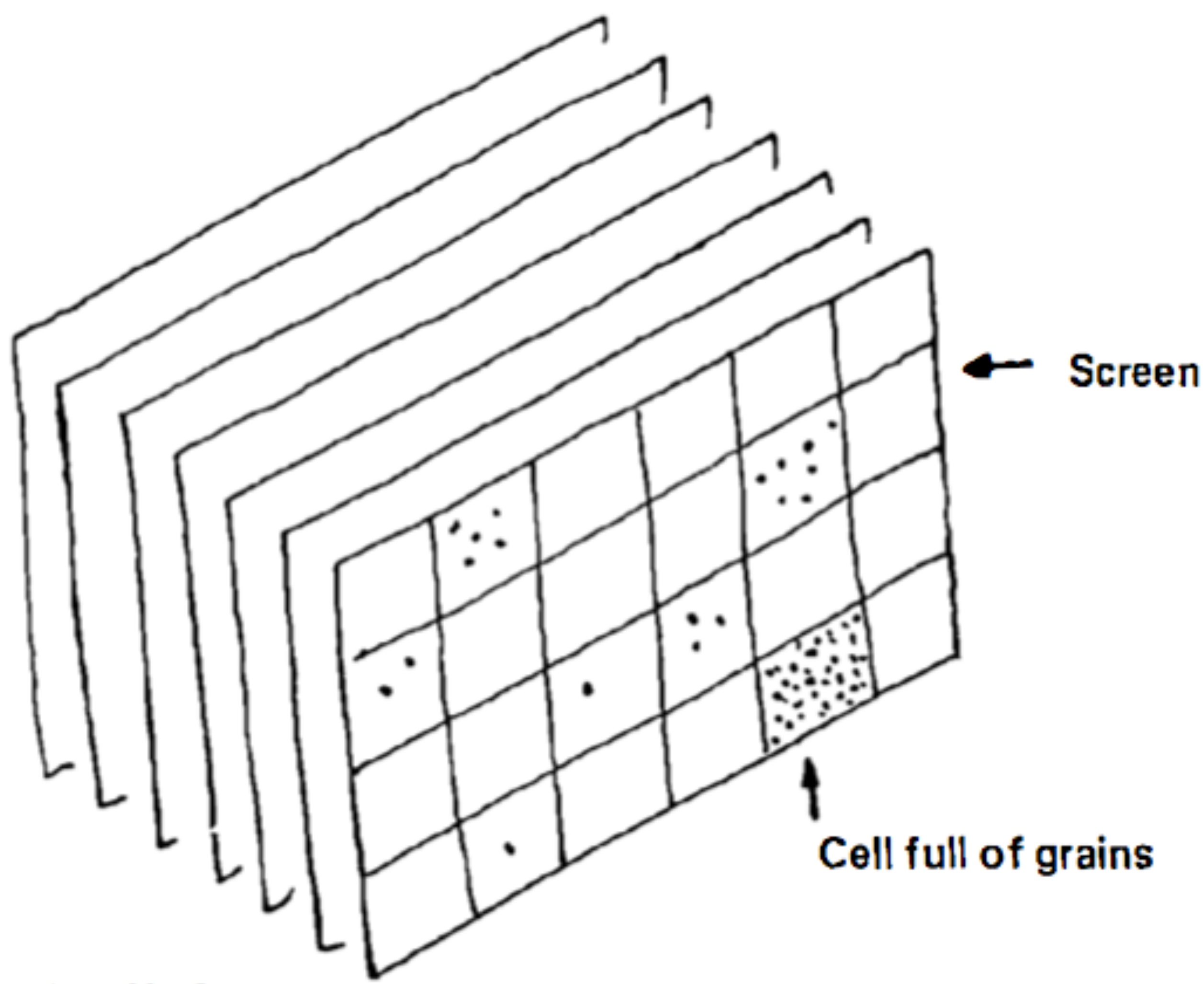


Fig. II–8

A book of screens equals the life of a complex sound

Xenakis - Concret PH (1958)

Stockhausen

"If the rate of beat is gradually increased beyond the time constant of the filter and the limits beyond which the ear can no longer differentiate, what started as a rhythmically repeated note becomes continuous. . . . We see a continuous transition between what might be called durational intervals which are characterized as rhythmic intervals and durational intervals characterized as pitch levels." (**Stockhausen**, 1955)

Pitch and rhythm can be considered as one and *the same concept*.

Serial method applied to rhythm as well as pitch. Creating a scale of durations that is interesting logically and perceptually remains a hard problem.

Curtis Roads

Realized his first granular study in 1974 using a **Music V** synthesis language.

Has written his own programs for granular synthesis. First with Algol, then C and recently with SuperCollider.

Author of many granular techniques such as **glisson**, **grainlet**, **trainlet** and **pulsar** synthesis. These are covered in detail in his book ***Microsound***.

Curtis Roads

Has written many pieces with granular synthesis and microsound such as **Nscor** (1980), **Half-life** (1999) and **Volt air** (2003).

Recent interests involve **convolution** in combination with microsound and **dictionary-based** granular synthesis.

Curtis Roads

"Electronic music gives us more than new timbres; it offers new tools for organizing sound material. New materials and tools lead to fresh compositional strategies based on timbral mutations, spatial counterpoint, detailed control of complex sound masses, graphical sculpting of time-varying spectra, juxtapositions of virtual and real soundscapes, sound coalescence and disintegration and interplay between the microsonic and the other time scales that cannot be realized by acoustic instruments."

Curtis Roads, Interview with Robindoré

Curtis Roads

Curtis Roads, **compositional processes**:

1. **Creation** of sound source material (playful)

2. The important phase of **classifying** and **editing** the source material (types and time-scales).

3. Make the **macroform puzzle**.
(*"It is as if each piece in the puzzle is a sound object with a potentially unique morphology. As I assemble the puzzle, certain objects appear to be natural matches: they fit in sequence or in parallel."*)

Curtis Roads - Then (2014)

Barry Truax

Achieved **real-time** granular synthesis in 1986. First version with sine waves and then frequency modulation, simple waveforms and later with long soundfiles.

Studied at the Institute of Sonology in Utrecht with Koenig.

Explored boundaries and usage of **synchronous** and **asynchronous** granular synthesis.

Barry Truax

Emphasizes a **soundscape** approach to composition as well as complexity and systems thinking.

Non linear approaches and **complexity** for control using for example parameter linking.

Barry Truax

"A new systems model in music and its processes will surely redefine the role of the composer or artist who until now has been seen as the mastermind of precisely controllable variables. The new paradigm will more likely see that person's role as a guiding element in a complex process that links artifact to context."

Barry Truax, 1992

Horacio Vaggione

Active in composition with *microsonic* materials since the 1970s.

Has mastered relating different **time-scales** in both highly original composition theory as well as being clearly perceptible in the music.

Famous for employing ‘**Micromontage**’, executing granular procedures by hand with a graphical editor.

Horacio Vaggione

Only discusses **micro** and **macro-time** but also holds that there exists a non-linearity between the levels, an **irreducibility** from one to the other.

For Vaggione, the domain of micro-time starts under the note.This domain is finite but **unlimited of temporal micro-scales** and opens access to a great number of sonic phenomena.

Horacio Vaggione

Gives attention to **interaction** between <u>algorithmic</u> processes and <u>musical</u> composition.

The problem of black box algorithmic composition is that the only way to intervene is to edit the output. Vaggione thinks of '**a plurality of diverse options**' rather than a single algorithm. This allows the composer to envisage '**direct actions**' or **interventions** (ecritures) to interact with the algorithm.

Horacio Vaggione

Vaggione does not believe in 'inner life', 'infinitesimal' since these ideas concern space while he sees things in form of **time**.

Time as irreversible, a sound cannot be seen in terms of periodicity but as a **dynamic**, **energetic phenomenon**.

The musical interest of a granular approach consists in the **musical treatment** (symbolic) of the elements present at the <u>microscale</u>.

Vaggione - Points Critiques (2011)

Manuella Blackburn - Petites Étincelles, ice breaker (2015)

Bjarni Gunnarsson - Ubieties (2015)

Granular Synthesis

A grain is a microsonic event typically lasting from **10-100 ms**.

Each grain has a **waveform** and an **envelope**. The waveform is often a small portion of a sampled sound but it can also be synthetic.

Thousands of grains are then played in succession (they can also overlap) to form **a higher level** sound object.

If **n** is the number of controls needed per grain, and **d** is the number of grains per second, then the total number of parameters is **<u>n times d</u>**.

Since n is normally greater than ten and d be greater up to one thousand, **a global strategy of organization** is required.

Granular Synthesis

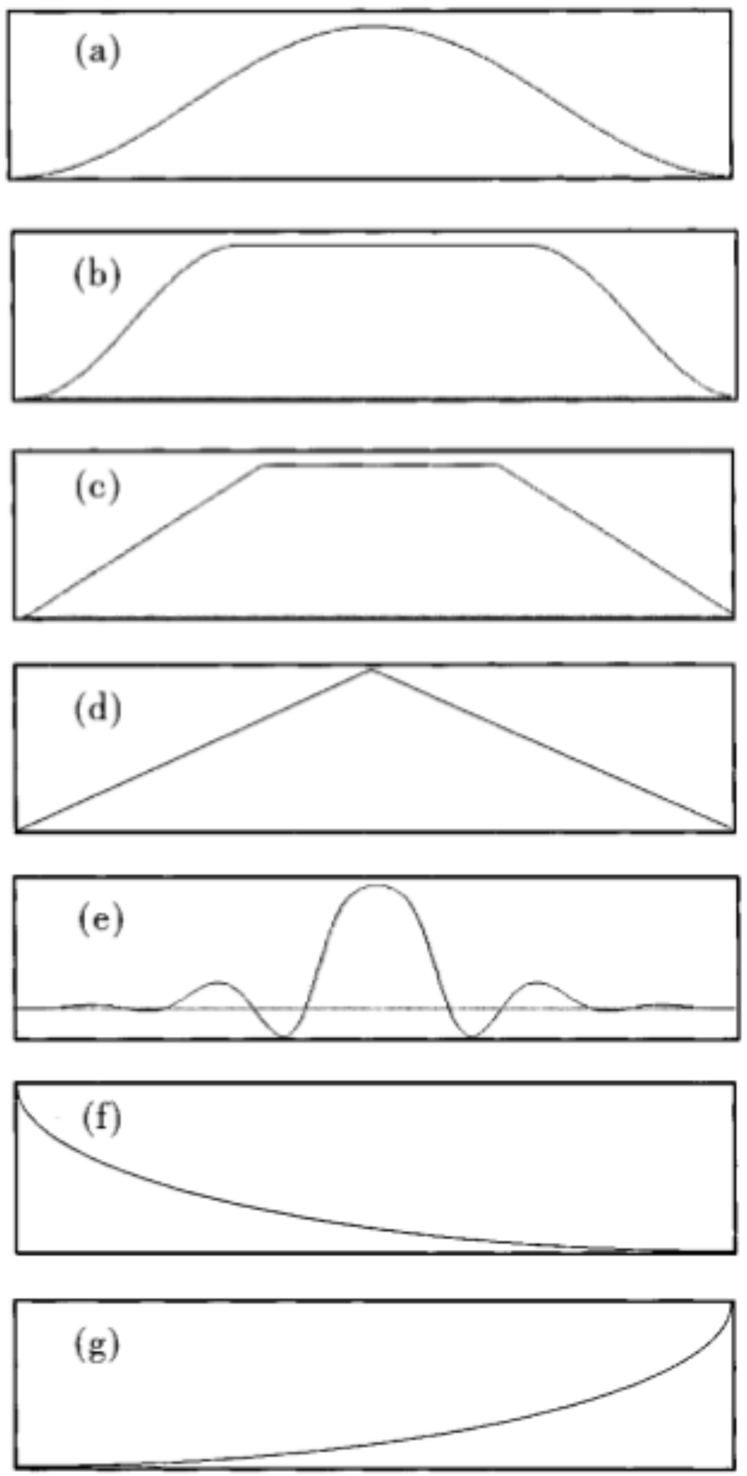
The characteristics of granular synthesis variants usually differ in the approach of globally organizing grains.

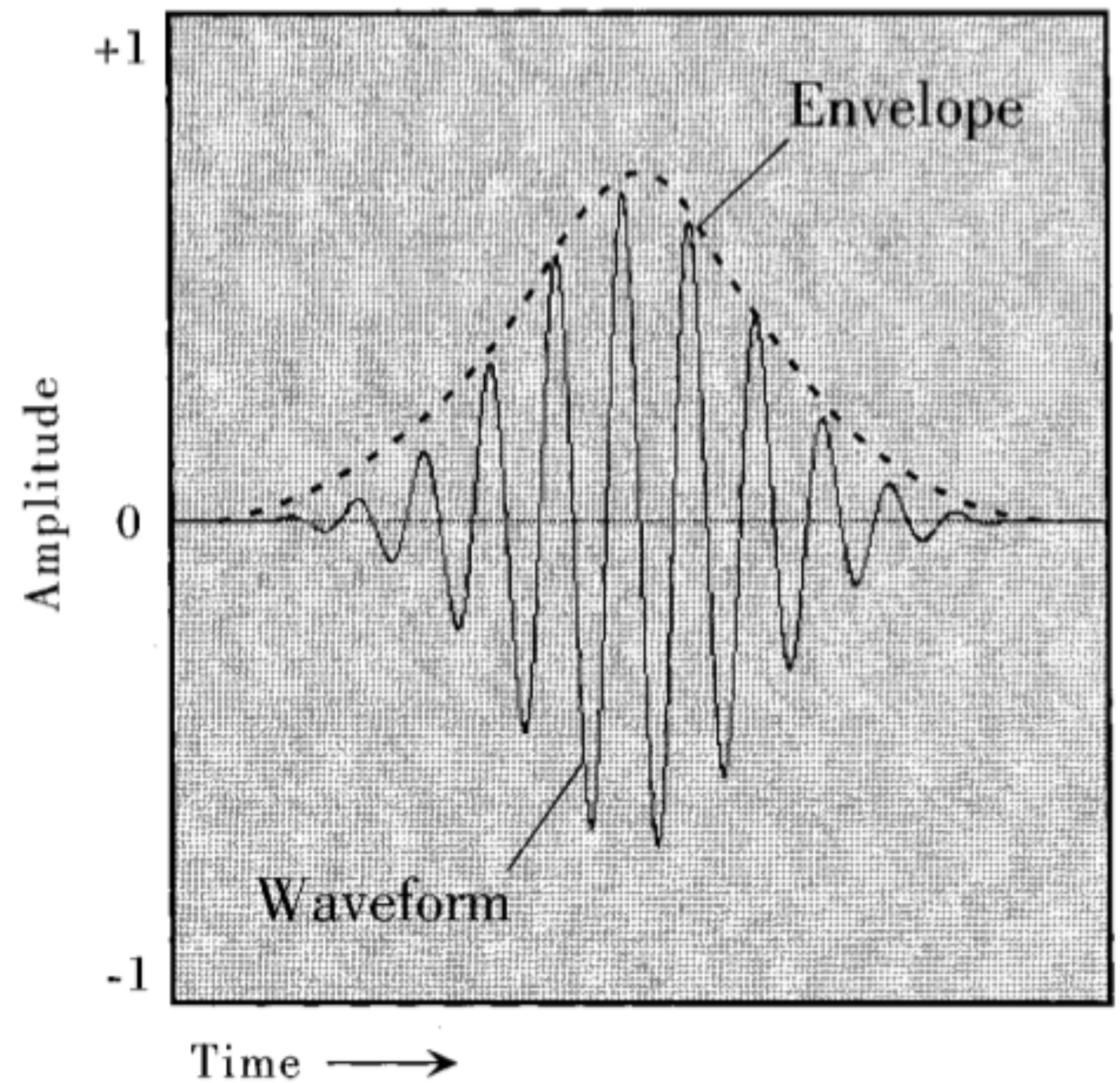
The most important parameters for this process are:

- **Density** of grains
- **Rate** of grain generation
- **Regularity** of grain generation
- **Duration** of each grain
- **Frequency**, **amplitude** and **waveform** of each grain.

Grains

Granular Synthesis





Curtis Roads, Microsound

Figure 3.2 Grain envelopes. (a) Gaussian. (b) Quasi-Gaussian. (c) Three-stage line segment. (d) Triangular. (e) Sinc function. (f) Expodec. (g) Rexpodec.

Granular Synthesis

Synchronous granular synthesis is when each grain is generated at a regular interval or rate.

Quasi-synchronous granular synthesis is when intervals are slightly deviated creating irregularity in the grain stream.

Asynchronous granular synthesis operates without regular intervals and generates grain masses instead by scattering grains according to a distribution algorithm.

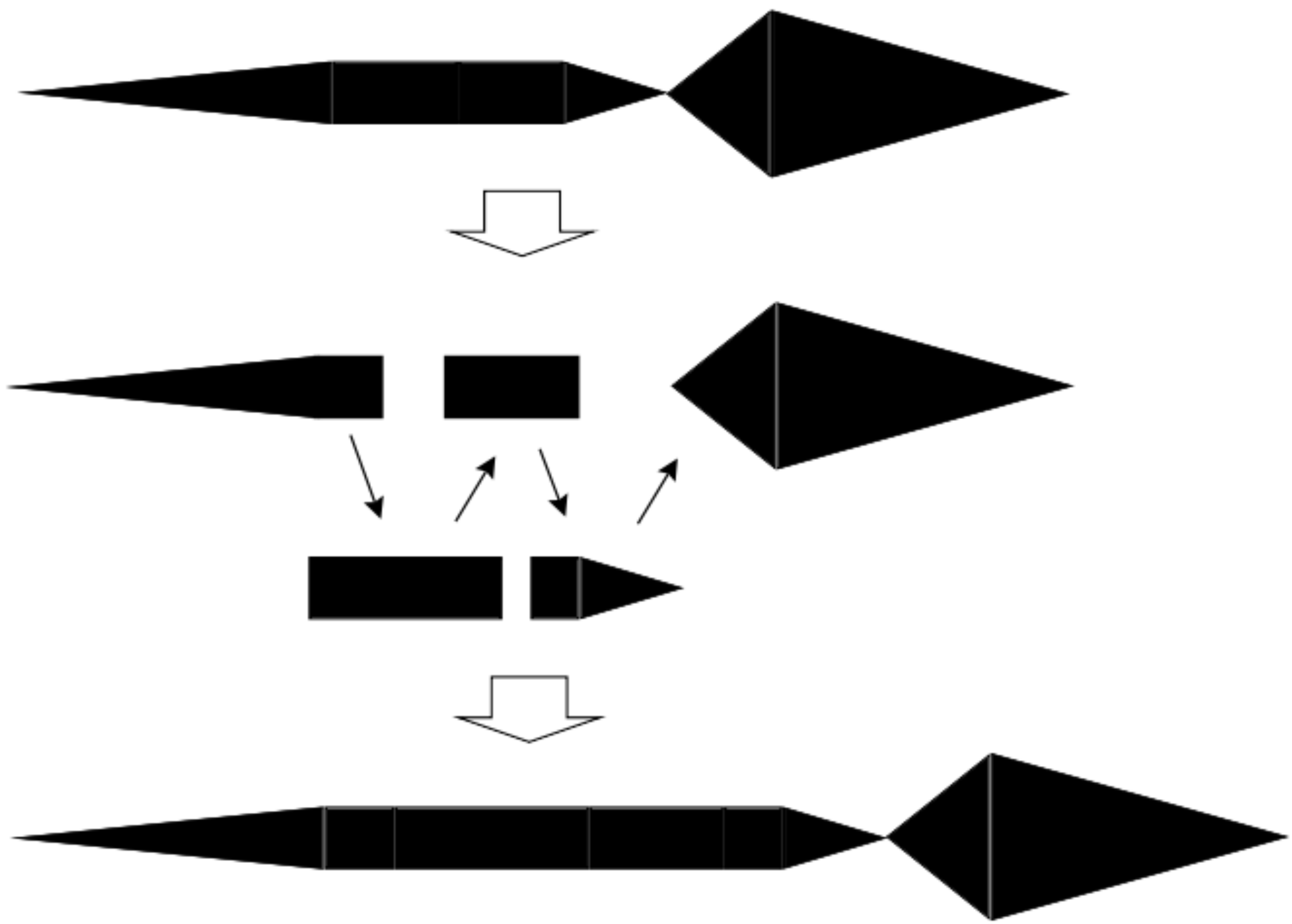
Granular Synthesis

The product of density and grain length is often referred to as the **fill factor**.

Density of grains can influence perceived pitch of an event and so can the grain envelope. In granular synthesis the control parameters are often **related** and **tightly coupled**.

Brassage

Strategies for how to read buffers with granular approaches is often referred to as *brassage*.



From Computer Sound Design & Synthesis Techniques (Miranda)

Granular Techniques

Pitch-time changing. Stretch or shrink the timescale of a sound without affecting its pitch.

Freezing. Stopping the grain read pointer. A single grain is read repeatedly, effectively “freezing” the sound.

Deterministic selection. The read pointer moves from left to right (in time order).

Random selection (scattering). The read pointer selects from random points in the sound file.

Granular Techniques

Grain size variation. Short grains induce noise into the signal.

Granulation with pitch-shifting. Each grain is pitch-shifted by a random amount within a range set by the user.

Granulation with filtering. Applying a band-pass filter to each grain, where the filter center frequency is random within a range set by the user.

(Curtis Road, Composing Electronic Music: A New Aesthetic)

Exercises

Exercises

1. Create a **granular texture** that evolves from dense to spare with at least two different voices created with a granular UGen and multichannel expansion.

2. Create a **movement of granular sound** that is controlled by audio rate waveforms (sine waves / lfnoise etc.) and that mixes more than one buffer to read from.

3. Experiment with **coupling parameters** so only 2-3 main are mapped to all the granular controls used.

4. Implement a **granular routine** where each grain is filtered, enveloped, speed-shifted and panned differently.