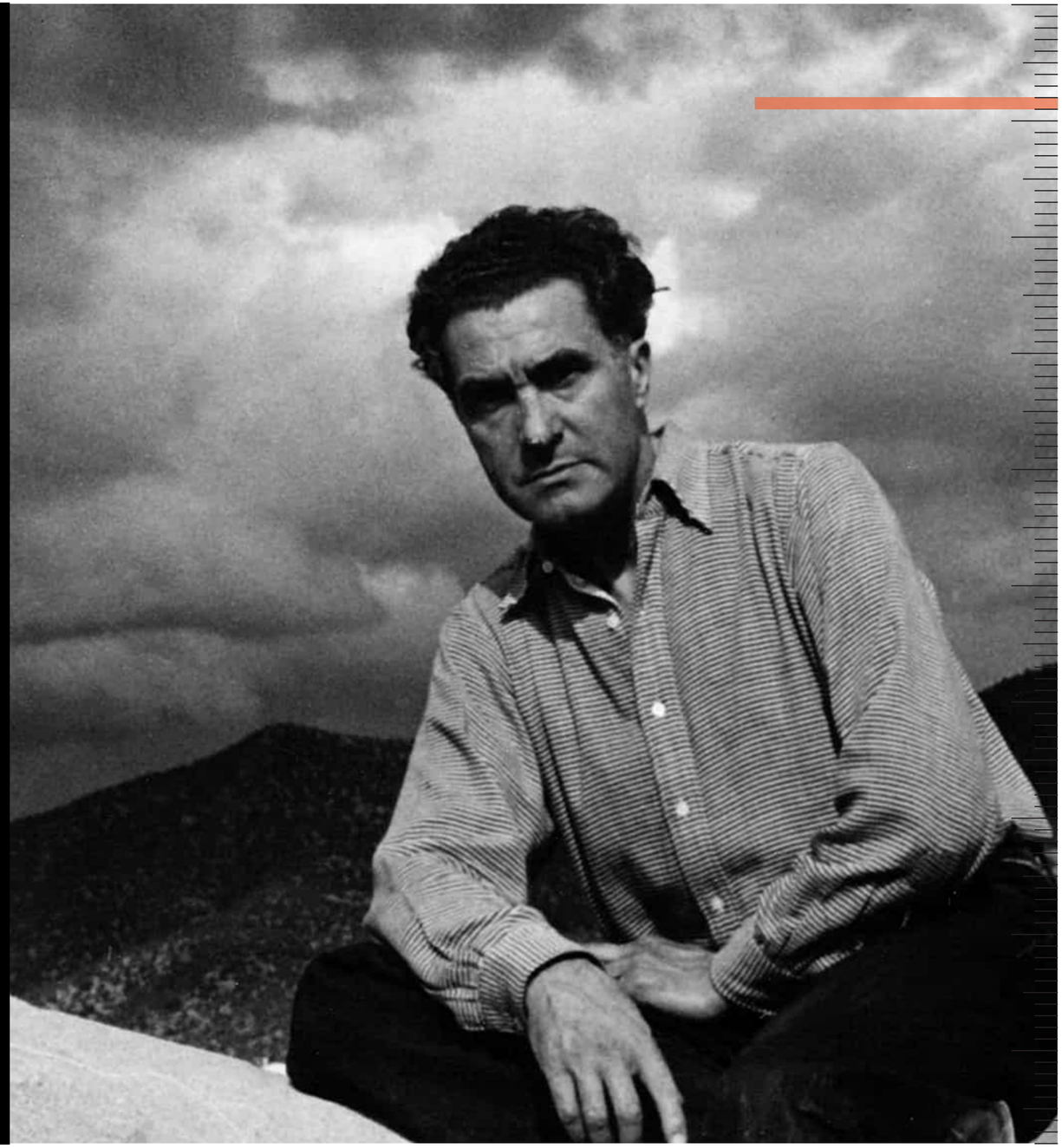
# THE LIBERATION OF SOUND

When new instruments will allow me to write music as I conceive it, taking the place of the linear counterpoint, the movement of sound-masses, of shifting planes, will be clearly perceived. When these sound-masses collide the phenomena of penetration or repulsion will seem to occur.

Certain transmutations taking place on certain planes will seem to be projected onto other planes, moving at different speeds and at different angles.

There will no longer be the old conception of melody or interplay of melodies. The entire work will be a melodic totality. The entire work will flow as a river flows.

— Edgard Varese



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# Exploring Granular Synthesis

1. Introduction
2. History
3. Practice
4. Hardware

Presenter:
**Stuart Frederich-Smith**

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signalfunctionset.com

# Time Scales of Music

Between the infinite and the infinitesimal, all scales of time are shown on this chart.

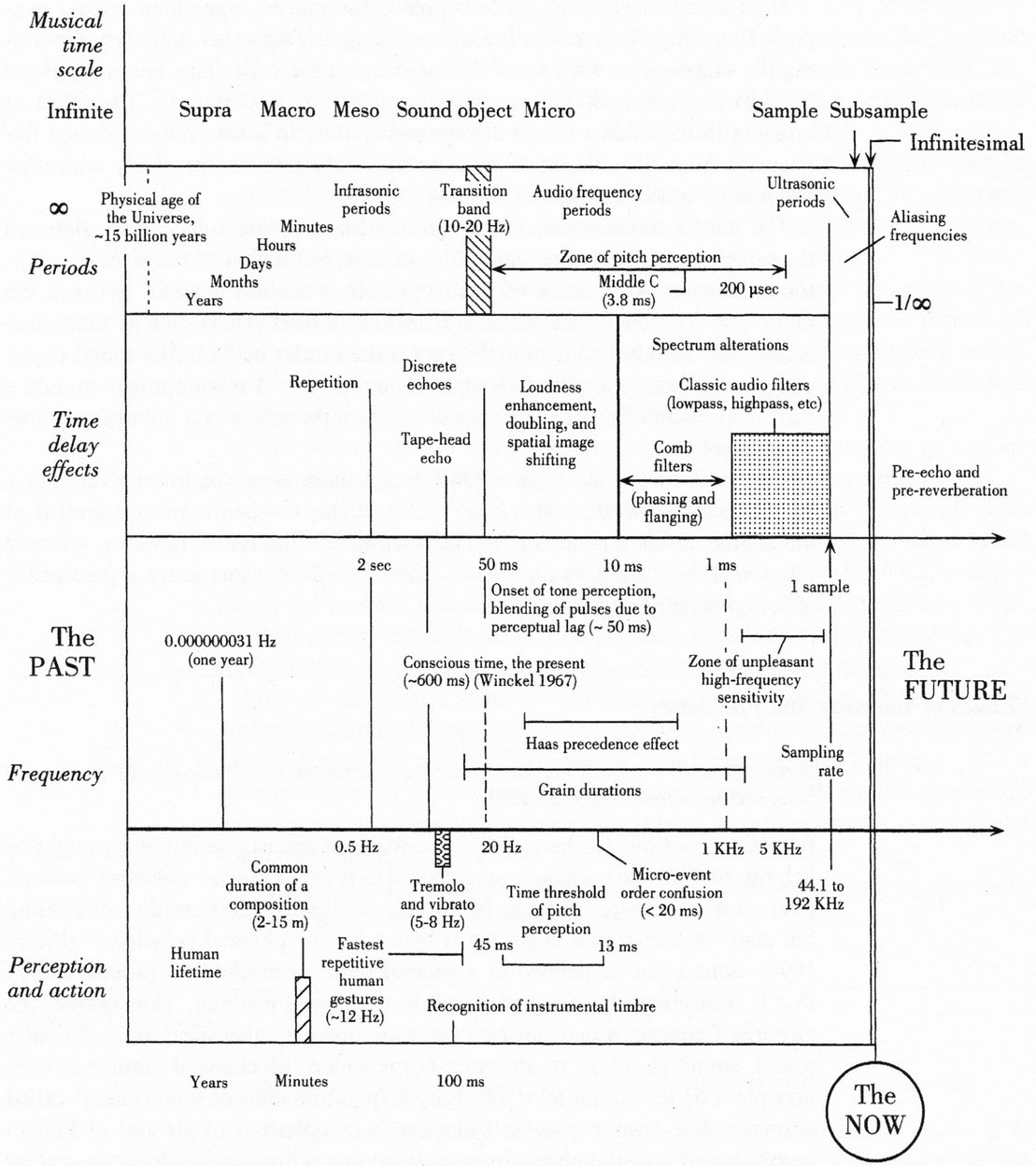



**Figure 1.1** The time domain, segmented into periods, time delay effects, frequencies, and perception and action. Note that time intervals are not drawn to scale.

# Introduction

1. **Introduction**
2. History
3. Software
4. Hardware

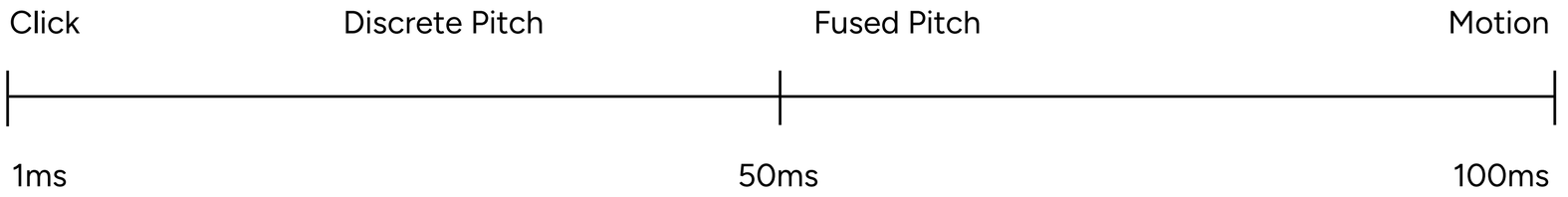
a. Granular vs Other Forms of Synthesis
b. Defining Granular Synthesis

# Granular Versus

**Subtractive Synthesis**
Subtractive starts with harmonically rich material and carves away. Granular starts with any sound and rebuilds it from fragments. One sculpts by removal, the other assembles from particles.

**Sampling**
A sampler plays back recorded sound more or less intact, typically preserving a specific element (drum strike -> full bar). Granular typically works at a much shorter time scale and is interested in reorganizing time.

# Defining Granular Synthesis




Granular synthesis uses very short (10-100ms) ‘grains’ of sampled audio to create sound.

Each grain is defined by the following attributes:

> Sound Material
> Duration
> Envelope shape

The timbre of grains may be adjusted by a variety of means:

> Pitch shift
> Sample Starting point
> Playback speed
> Playback direction

# Sound Material

There are two traditional camps in granular synthesis.

**Synthetic** creates grains from simple wave forms (Sine, Ramp, Square, etc.) as its sound material.

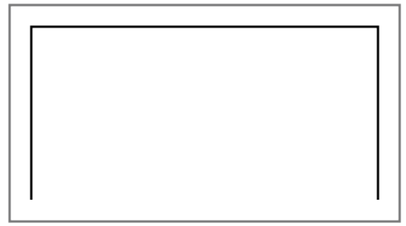
**Granulation** creates grains from arbitrary, often more complex or changing sound material.

# Grain Envelopes

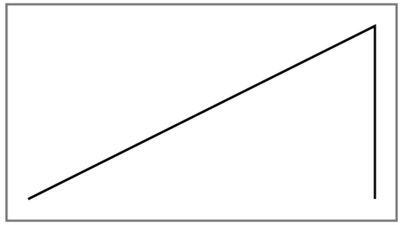
All granular syntheSizers provide control over the envelope shape.

Square, Down Ramp (and Exp.) and Tukey have strong transients.

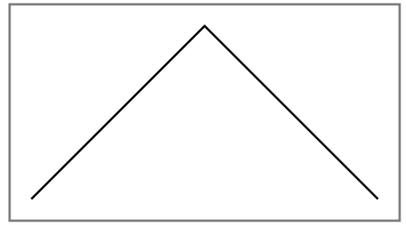
Triangle and Hamming have weak transients, but strong Blend across grains.



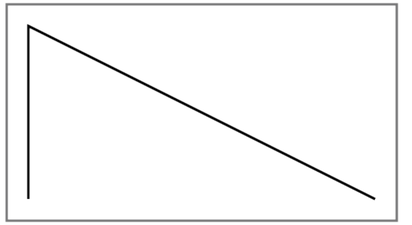
Square



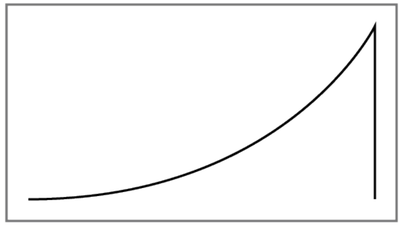
Up Ramp



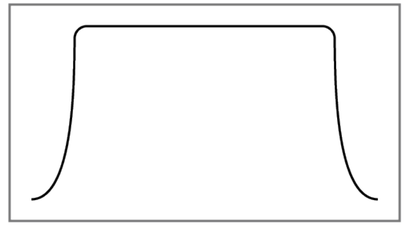
Triange



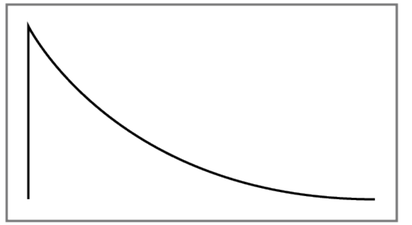
Down Ramp



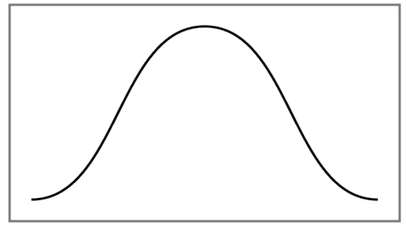
Up Ramp Exponential



Tukey



Down Ramp Exponential



Hamming

# Grain Clouds

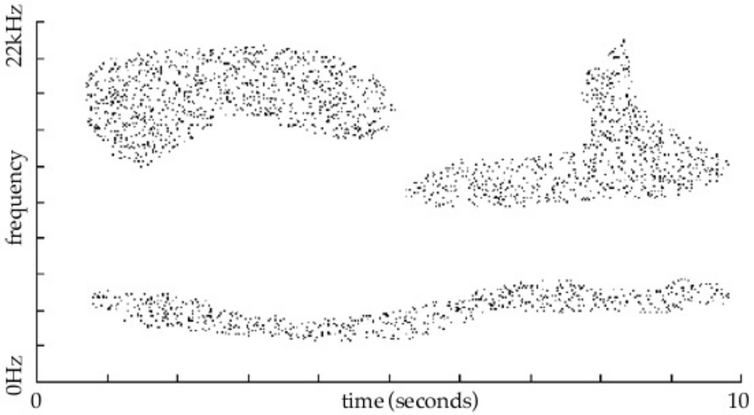
**A grain cloud is what you hear when many grains are triggered in rapid succession or overlapping streams.**

Instead of perceiving individual discrete fragments, the ear fuses them into a continuous texture.

Water Droplet:: Real Cloud
Grain::Granular Cloud

The character of the cloud depends on a few key variables:

- how densely the grains overlap (density/rate)
- how long each grain lasts (size)
- what part of the source each grain is taken from (position)
- how each grain fades in and out (envelope shape)



# History

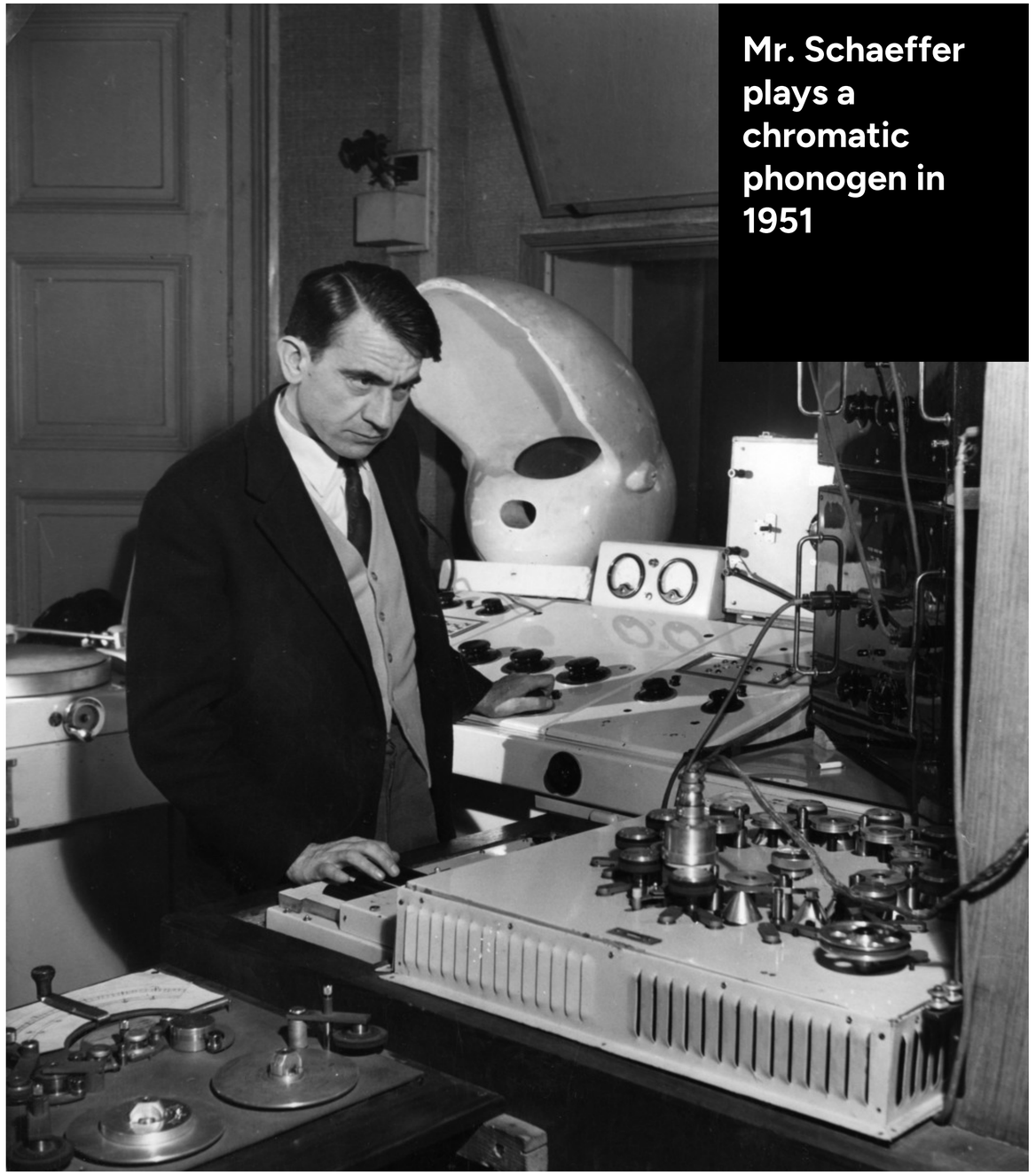
1. Introduction
2. **History**
3. Theory
4. Practice
5. Hardware

a. Tape and early synthesis: granular as concept
b. Software era - granular as instrument
c. Hardware era - granular for all

# Étude Pathétique

**Pierre Schaeffer**

- Created at the Studio d’Essai of French Radio in Paris
- Built from manipulated recordings of a soup pan, piano and other acoustic sources
- Schaeffer cut, looped, reversed, and reassembled on tape.



Mr. Schaeffer plays a chromatic phonogen in 1951

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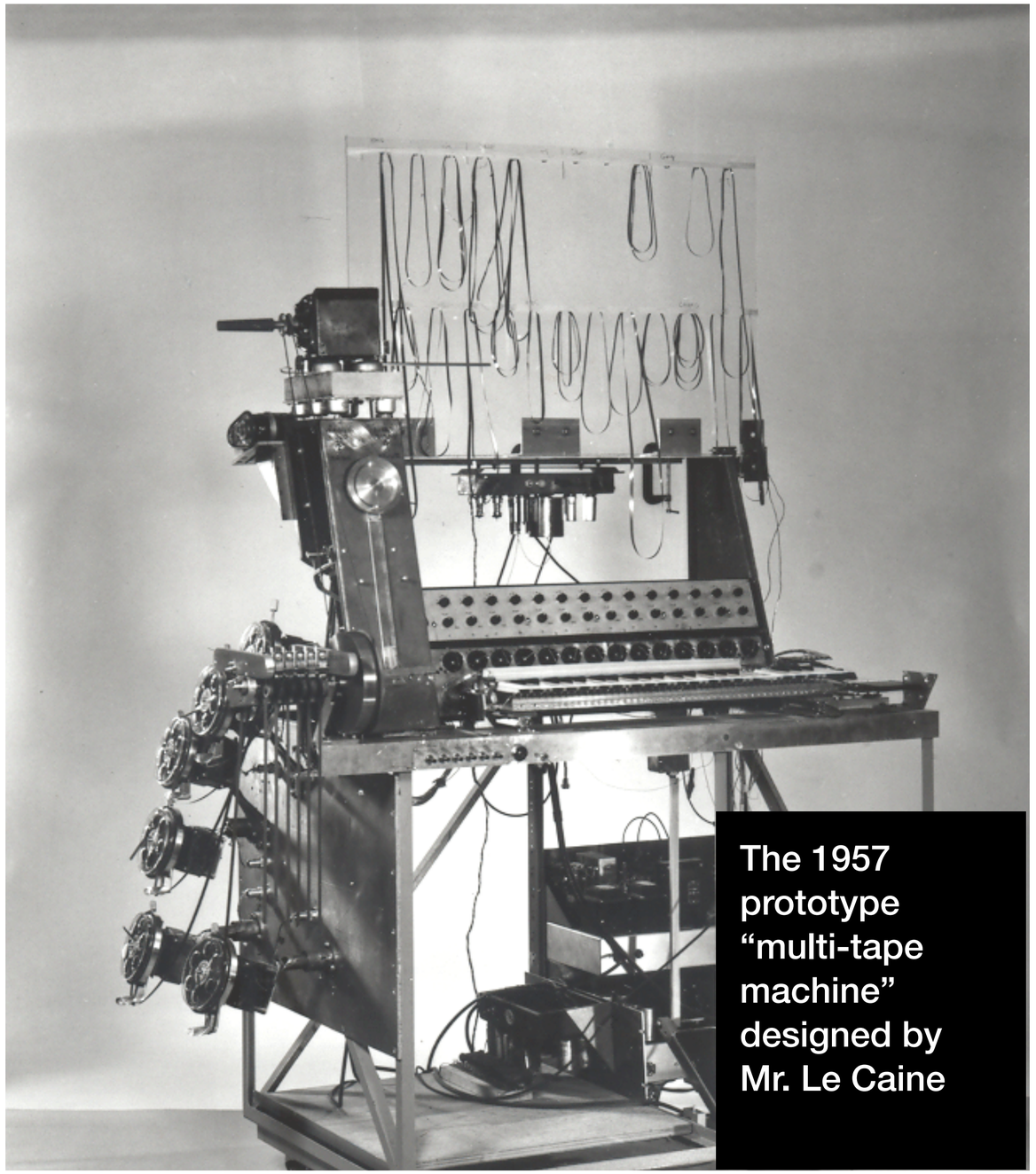
# Dripsody (1955)

**Hugh Le Caine**

- Composed through manipulation of a single water drop sample
- Created on a machine of his own devising called the multi-track.

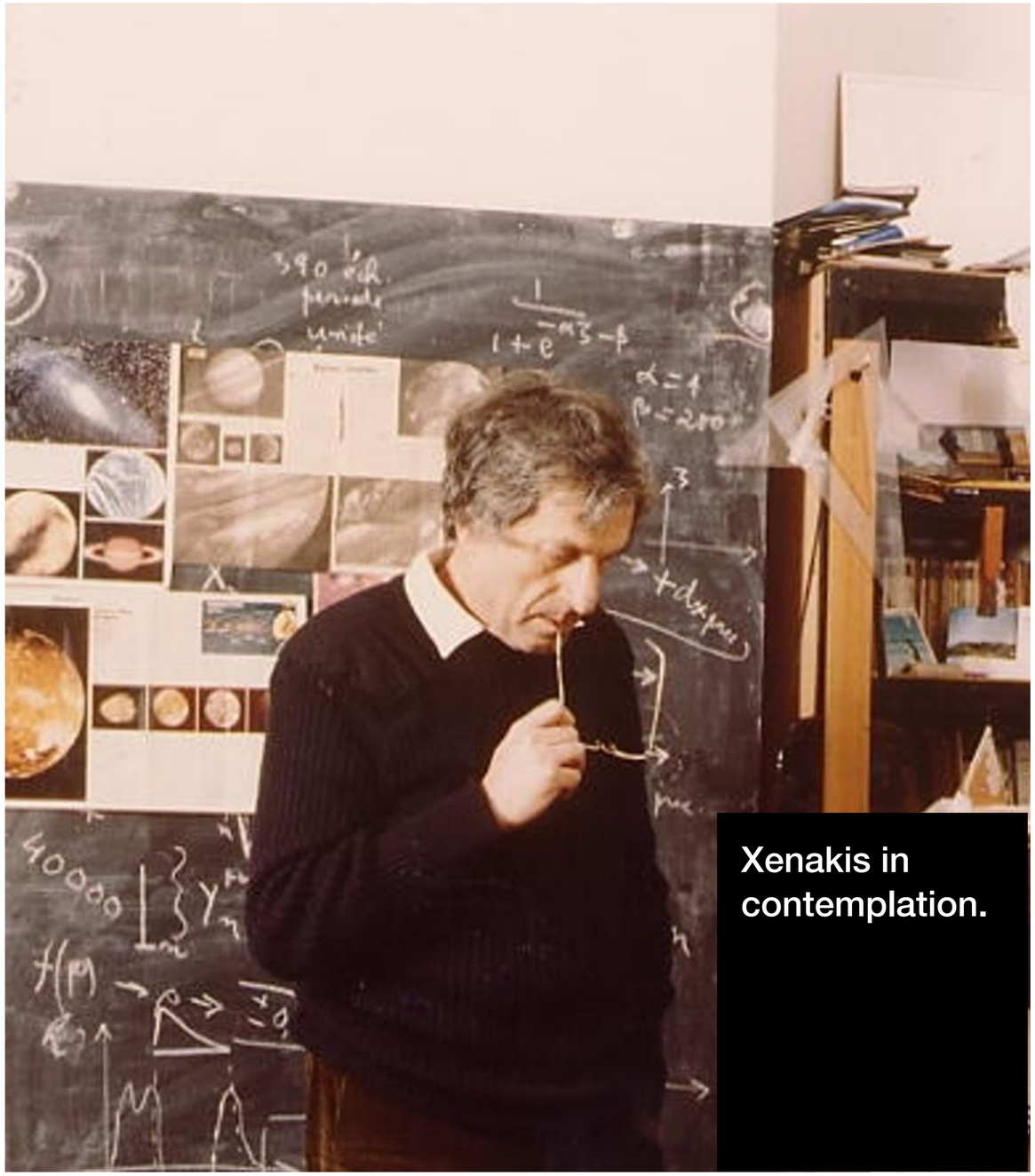


The 1957 prototype “multi-tape machine” designed by Mr. Le Caine

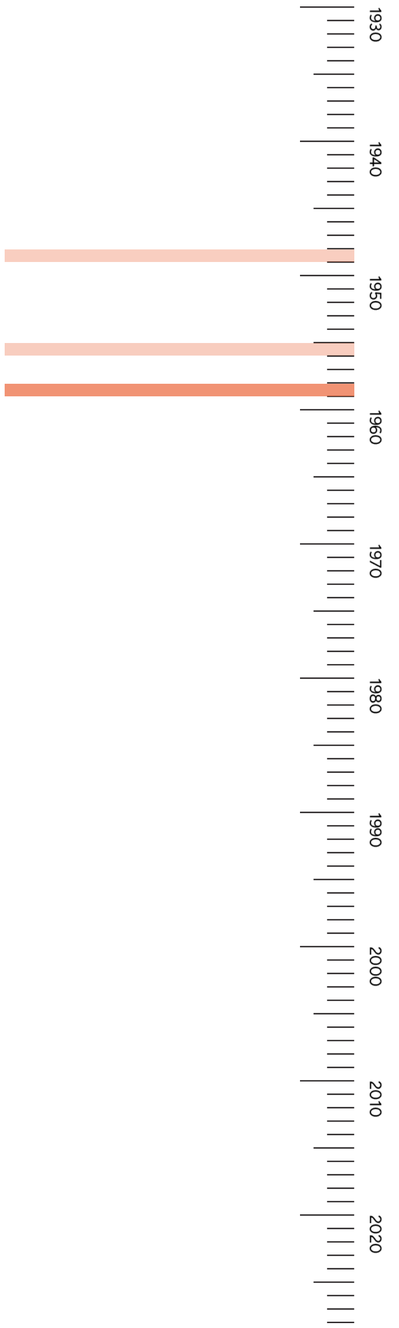
# Concret PH (1958)

**Iannis Xenakis**

- Built from 1-second fragments of burning charcoal
- Layered and organized to create unified sonic texture
- First branch from musique concrète toward granular composition
- Focus on texture and density rather than dramatic transitions



Xenakis in contemplation.

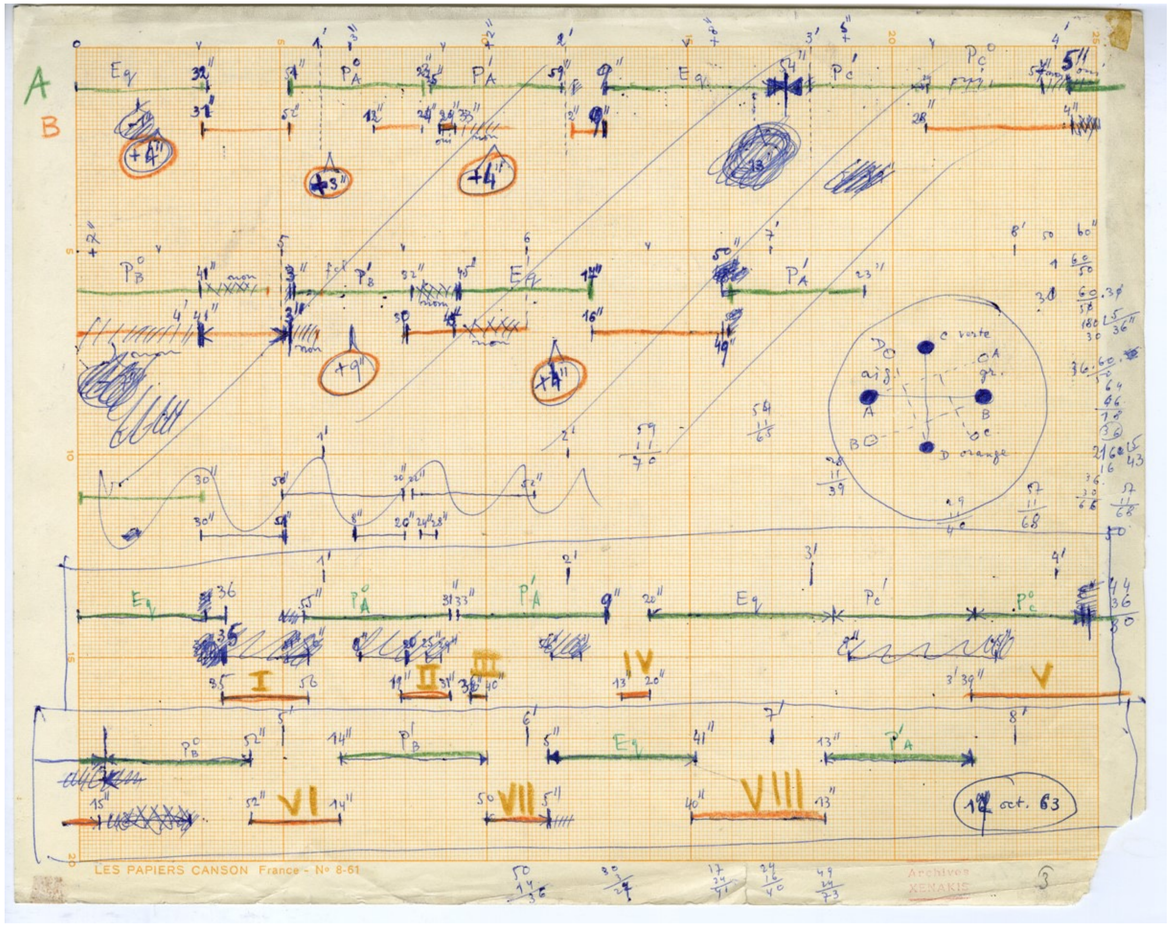


# Analogique A-B (1959)

Draft score for Analogique A-B

**Iannis Xenakis**

- Gives us the term "grains of sound"
- Part A: strings | Part B: granulated sine waves from tone generators
- Stochastic (statistically-derived) composition governs grain distribution
- "All sound is conceived as an assemblage of elementary sounds adequately disposed in time"

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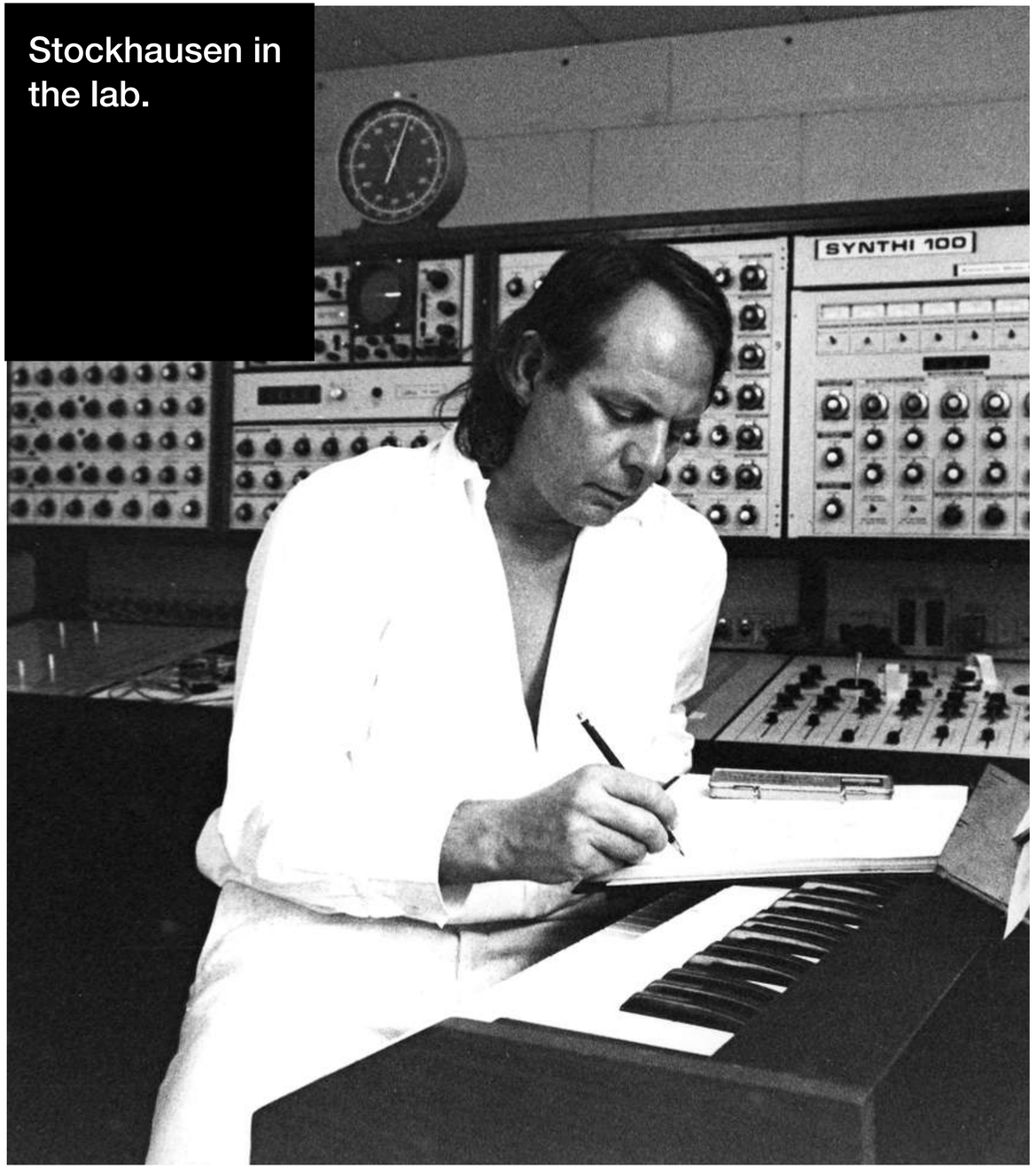
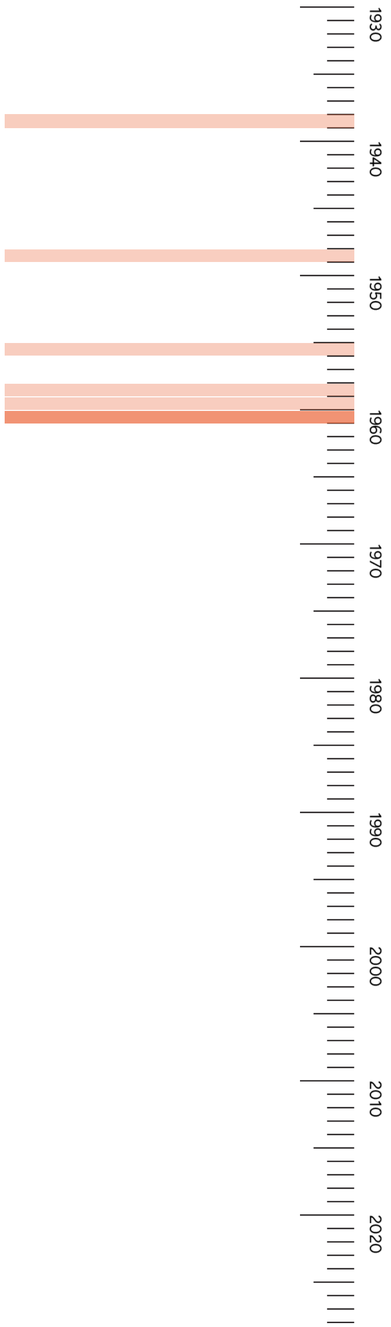
# Kontakte (1960)




Stockhausen in the lab.

**Karlheinz Stockhausen**

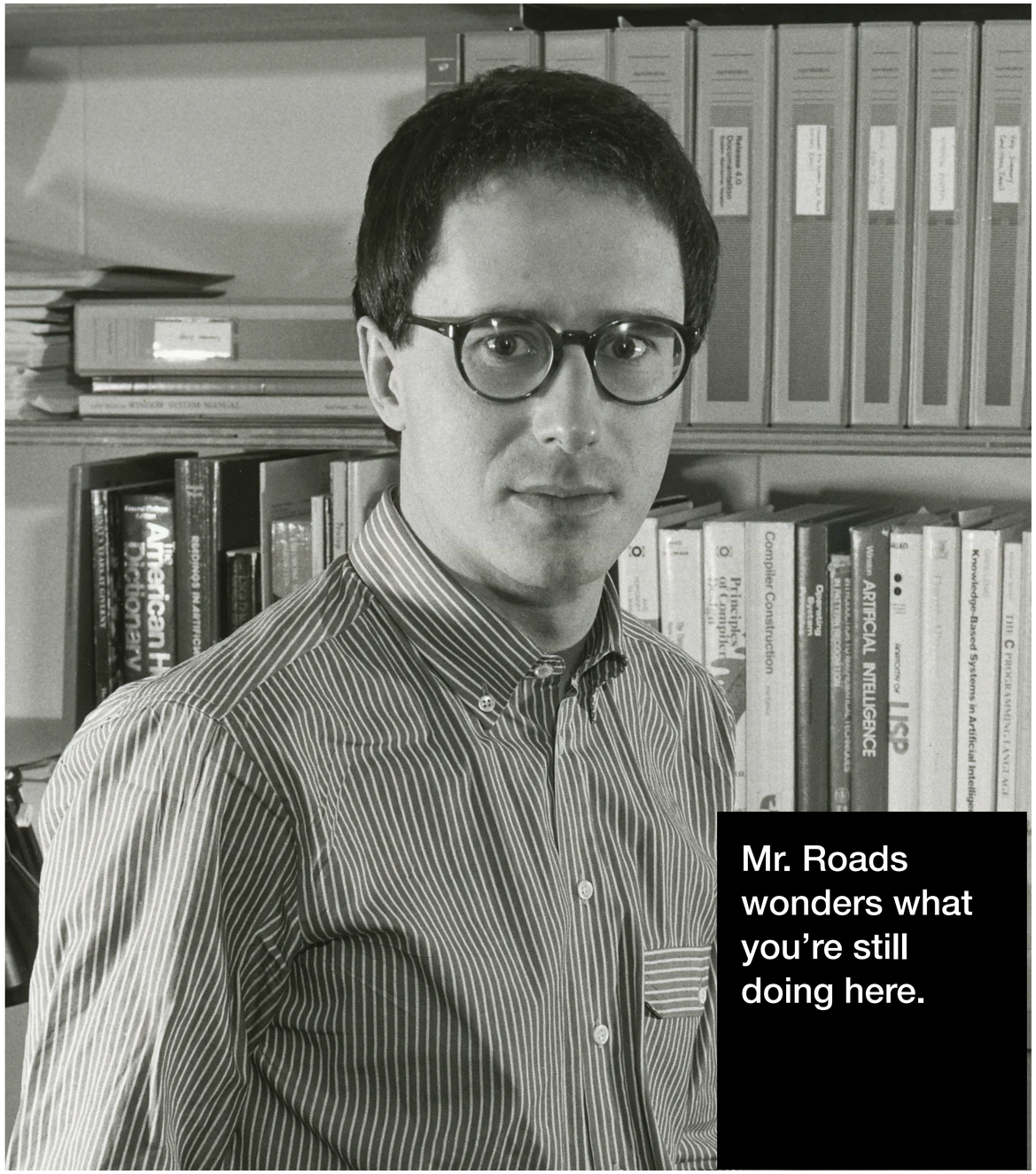
- Synthetic source material: sine tones, filtered noise, impulses
- Demonstrates pitch and rhythm as a single continuum
- Speed up pulses → pitch
- Slow down pitch → rhythm
- A key conceptual foundation for granular parameter thinking

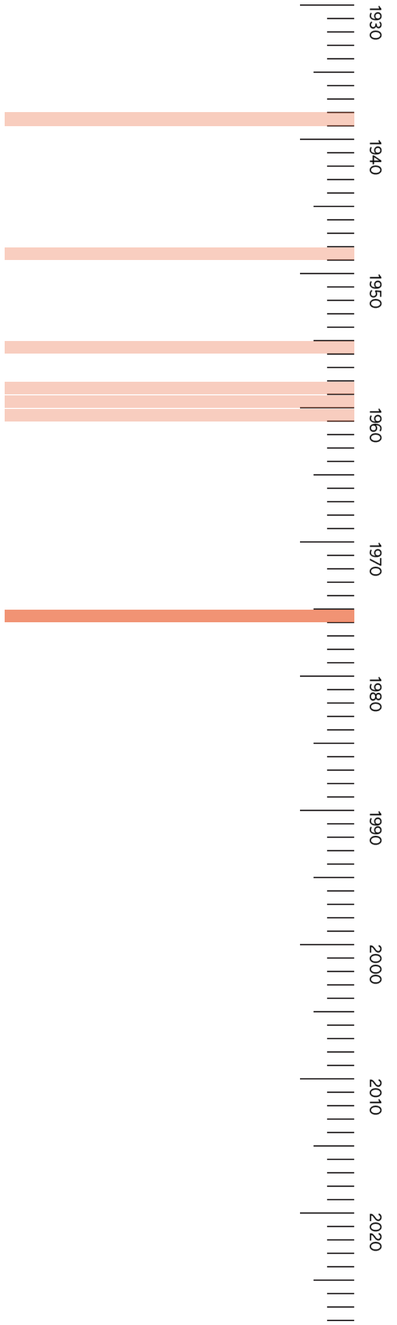


# Granular Study (1975)

**Curtis Roads**

- First digitally-constructed granular compositions
- Required asynchronous processing: write program, execute, wait
- 1978 Computer Music Journal article codified the field
- Foundation for decades of software development to follow



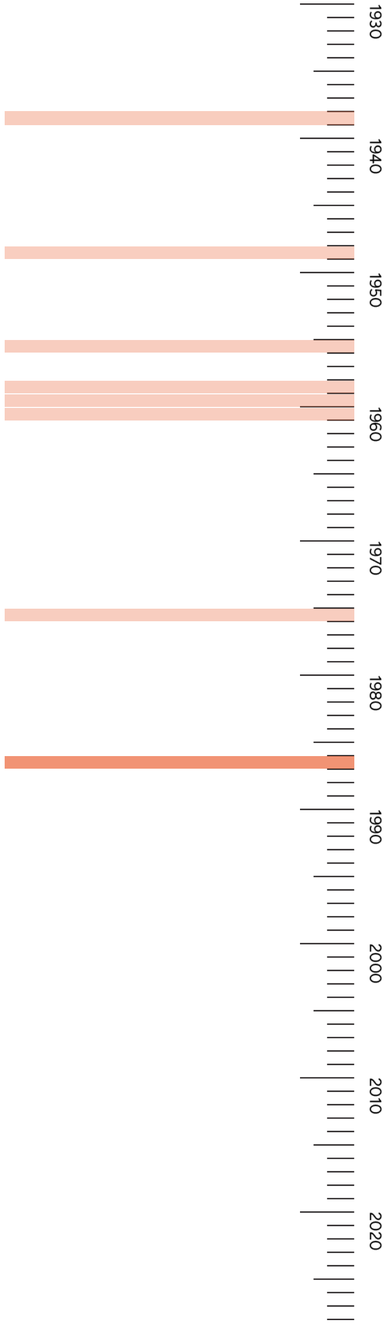



# Riverrun (1986)



**Barry Truax**

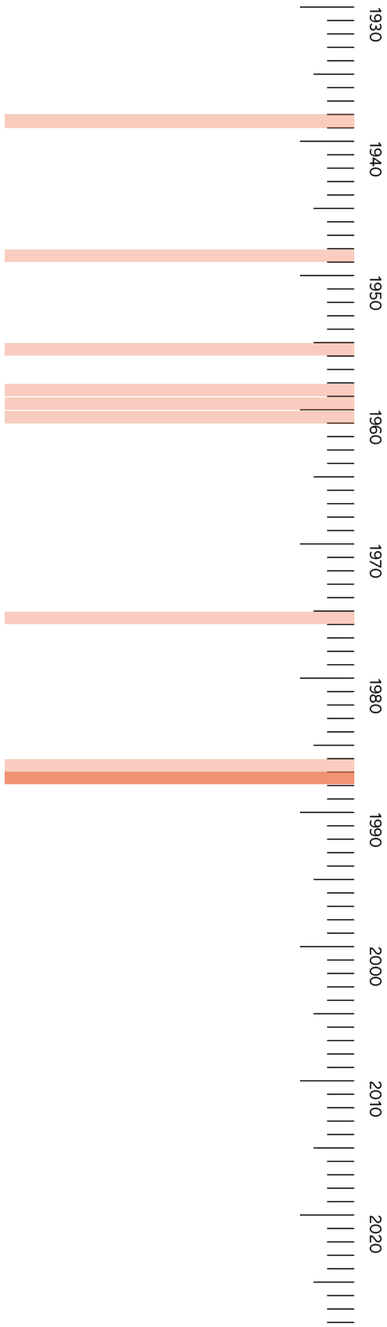
- First real-time granular synthesizer: GSX on the DMX-1000 DSP
- Adjustable parameters: source, envelope, frequency, density, panning
- Multi-stage ramps modulate characteristics over time
- Real-time control transforms granular from theory to instrument



# Wings of Nike (1987)

**Barry Truax**

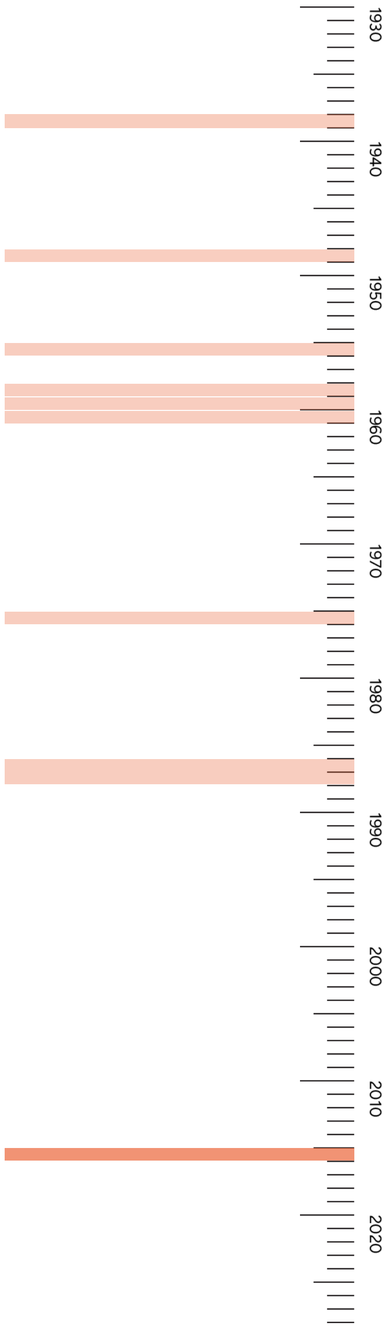
- First real-time granular processing of sampled source material
- Arbitrary audio (including voice) granularized and modulated
- The ear tries to reconstruct the source, always at the edge of recognition
- Opens granular synthesis to infinite timbral possibility



# Clouds (2015)

**Émilie Gillet (Mutable Instruments)**

- Not the first hardware granulator, but the one that went mainstream
- Real-time, hands-on, voltage-controllable, no menu diving
- Open-source firmware spawned dozens of variants
- Granular synthesis becomes a patch cable away



# Theory

1. Introduction
2. History
3. **Practice**
4. Hardware

a. EmissionControl 2
b. GSX (VCV Rack)
c. Clouds (VCV Rack)

# Theory

1. Introduction
2. History
3. Practice
4. **Hardware**
    a. Clouds
    b. Morphagene
    c. Multigrain
    d. Mojave

# Four Eurorack Granular Processors

| Parameter | Clouds | Morphagene | Multigrain | Mojave |
|---|---|---|---|---|
| Source | Live input only | Reels on microSD (2.9 min) | Samples (32s) or Live Sounds | Live input only |
| Position | Position | Slide | Start + Scan | Zone |
| Grain Size | Size (10ms - 100ms) | Gene-Size (10ms - 2.9m) | Size (20ms–4s) | Size (20ms–4s) |
| Pitch | Pitch (±2 oct) | Vari-Speed (+12/−26 semi) | Pitch (±2 oct) | Speed (±2 oct) |
| Pitch Quantize | — | — | Per-sound quantizer | Sky Modes (scales) |
| Density/Rate | Density | Morph (overlap) | Rate (0–130Hz) | Rate (0–130Hz) |
| Clock Sync | Trigger input | Clock (Gene Shift/Time Stretch) | Sync (÷16 to ×16) | Clock (÷8 to ×8) |
| Envelope Shape | Texture (3 morphing) | — | SHAPE (7 morphing) | Window (5 morphing) |
| Position Spray | Modulate Position | Modulate Slide | Modulate Start | Drift knob |
| Pitch Random | Modulate Pitch | Extreme Morph | Modulate Pitch | Structure knob |
| Stereo Spread | Blend (Spread mode) | Extreme Morph | — | Whirl knob |
| Filter | — | — | Tone (LP/HP) | — |
| Reverb | Blend (Reverb mode) | — | Blur | Gust (CW) |
| Feedback | Blend (Feedback mode) | Time Lag Accumulation | — | Gust (CCW) |
| Freeze | Freeze button/gate | — | Looping Recorder Freeze | Lock button/gate |
| Multi-Sound | — | Splices (up to 300) | 8 Sounds | — |
| Scene System | 4 buffer slots | 32 Reels | 48 Projects × 48 Presets | Narwhal presets |
| CV Outputs | — | Envelope + EOSG | 6 configurable options | Dune (morphing CV) |

# Clouds

| Parameter | Control | Notes |
|---|---|---|
| Position | POSITION knob + CV | Where in buffer grains are taken |
| Size | SIZE knob + CV | Grain length |
| Pitch | PITCH knob + V/Oct CV | ±2 octaves transposition |
| Density | DENSITY knob + CV | Noon = no grains; CW = random; CCW = constant rate |
| Texture | TEXTURE knob + CV | Envelope shape (square → triangle → Hann); extreme = diffuser |
| Blend | BLEND knob + CV | 4 functions: dry/wet, spread, feedback, reverb |
| Freeze | Button + gate | Stops recording, granularizes frozen buffer |
| Trigger | Gate input | Generates single grain (Density at NOON) |
| Quality | 4 settings | Trades buffer length for fidelity (8-bit lo-fi option) |
| Alt Engines | 3 modes | Pitch-shifter/stretcher, looping delay, spectral (FFT) |

# Morphagene

| Parameter | Control | Notes |
|---|---|---|
| Gene-Size | Knob + CV | Shrinks playback from full Splice to microsound |
| Vari-Speed | Knob + CV | Speed/direction; center = stopped |
| Slide | Knob + CV | Scrubs through Splice, offsets Gene start |
| Organize | Knob + CV | Selects next Splice (waits for current to end) |
| Morph | Knob + CV | Overlap: gap → 1/1 → 2/1 → 3/1 → random pitch/pan |
| S.O.S. | Knob + CV | Sound on Sound mix (input ↔ playback) |
| Play | Gate input | Retriggers from Splice start |
| Clock | Input | Gene Shift (Morph ≤2/1) or Time Stretch (Morph >2/1) |
| Recording | REC button + gate | TLA overdub or Record into New Splice |
| Storage | microSD | Up to 32 Reels, 2.9 min each, 300 Splices per Reel |

# Multigrain

| Parameter | Control | Notes |
|---|---|---|
| Start | Knob + CV | Grain start position in sample |
| Wrap | Knob + CV | Boundary for Scan movement |
| Scan | Knob + CV | Advances position through Wrap area |
| Shape | Knob + CV | 7 envelope options (Bell, Sinc, Triangle, etc.) |
| Rate | Knob + CV | 0–130Hz, or clock-synced ÷16 to ×16 |
| Size | Knob + CV | 20ms–4s (extendable to 8s or sample length) |
| Pitch | Knob + CV | ±2 octaves, per-sound quantizer available |
| Tone | Knob + CV | 2-pole filter: LP (CCW) / HP (CW) |
| Blur | Knob + CV | Reverb send + decay |
| Morph | Fader + CV | Interpolates between Scene A and Scene B |
| Modulation | RAND, X, Y, Z | Assignable to any parameter per scene |
| Sounds | 8 slots | Samples or Live Sounds, SELECT CV for sequencing |
| Storage | microSD | 48 Projects × 48 Presets |

# Mojave

| Parameter | Control | Notes |
|---|---|---|
| Rate | Knob + CV | Grain frequency 0–130Hz; clock-synced ÷8 to ×8 |
| Size | Knob + CV | 20ms–4s; CCW = reverse, CW = forward |
| Zone | Knob + CV | Buffer position; becomes scrubber when Locked |
| Speed | Knob + CV | Pitch ±2 octaves, 1V/Oct tracking |
| Window | Knob + CV | 5 envelope shapes |
| Distribute | Knob + CV | Rhythmic variations (free = random; quantized = ratchets) |
| Structure | Knob + CV | Melodic randomization (semitones → octaves → arpeggios) |
| Drift | Knob + CV | Position randomization per grain |
| Whirl | Knob + CV | Stereo spread per grain |
| Gust | Knob + CV | Feedback (CCW) ↔ Reverb (CW) |
| Sky Modes | 4 modes | Dawn (Major), Day (Minor), Dusk (Chromatic), Twilight (Free) |
| Gen Modes | 3 modes | Erode (clock), Shear (threshold), Chisel (manual) |
| Lock/Freeze | Buttons + gates | Lock = freeze buffer; Freeze = freeze grains |
| Dune | CV output | Morphing voltage, grain triggers, or clock passthrough |

# Thank You

Course content will be shared at signalfunctionset.com later this weekend.

Download GSX on VCV Rack

Follow **@shotsy** on Instagram for occasional music

Please take the survey!