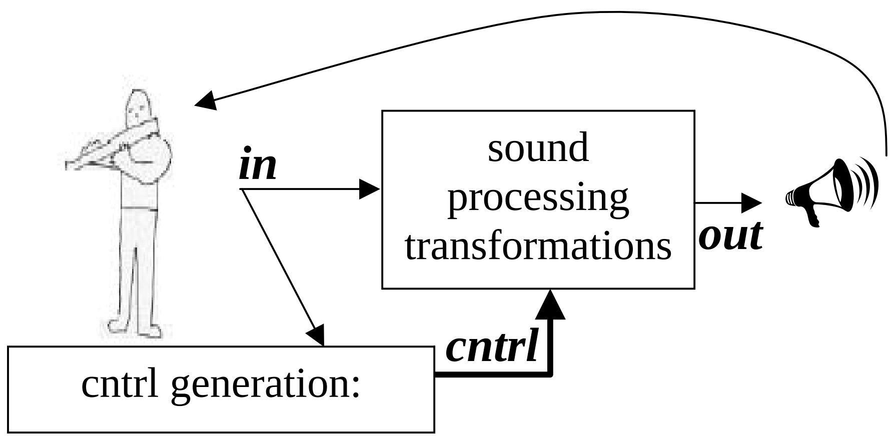
examples from compositional work:

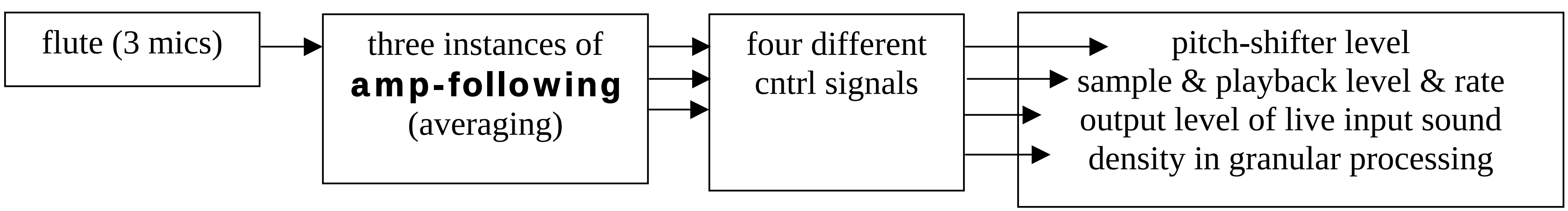
BOOK OF FLUTE DYNAMICS flute and adaptive digital-signal-processing (duo)

sound-specific processing transformations



out = f (in, cntrl)
cntrl = f(in)
in = f(score, out)
score = score

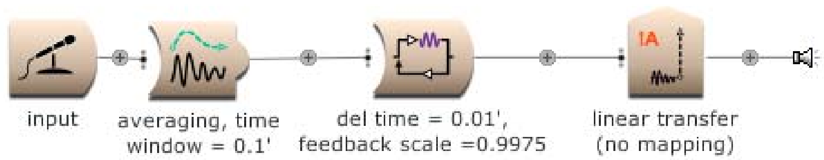
role of musical score: scheduling of sound materials <u>AND</u> device driving the software process



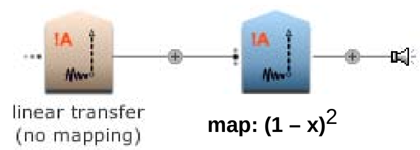
cntrl-signals implemented for *Book of Flute Dynamics*

the cntrl-sig so generated drives (a) amp scale and (b) playback rate in a sample&playback process to which the input sound is subjected

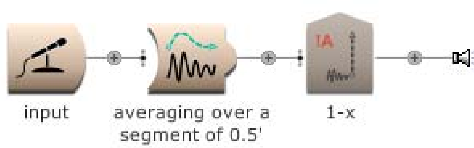
(a) **amp-to-amp** mapping : (0, 0.5, 1) => (1, 0, -1), so resultant driving signal is inverse and bipolar
(b) **amp-to-rate** mapping : (0, 1) => (58, 62) nn, where 60 = no rate shift (same pitch as input sound)



drives the amp scale in a pitch-shifted and much delayed version of the input sound

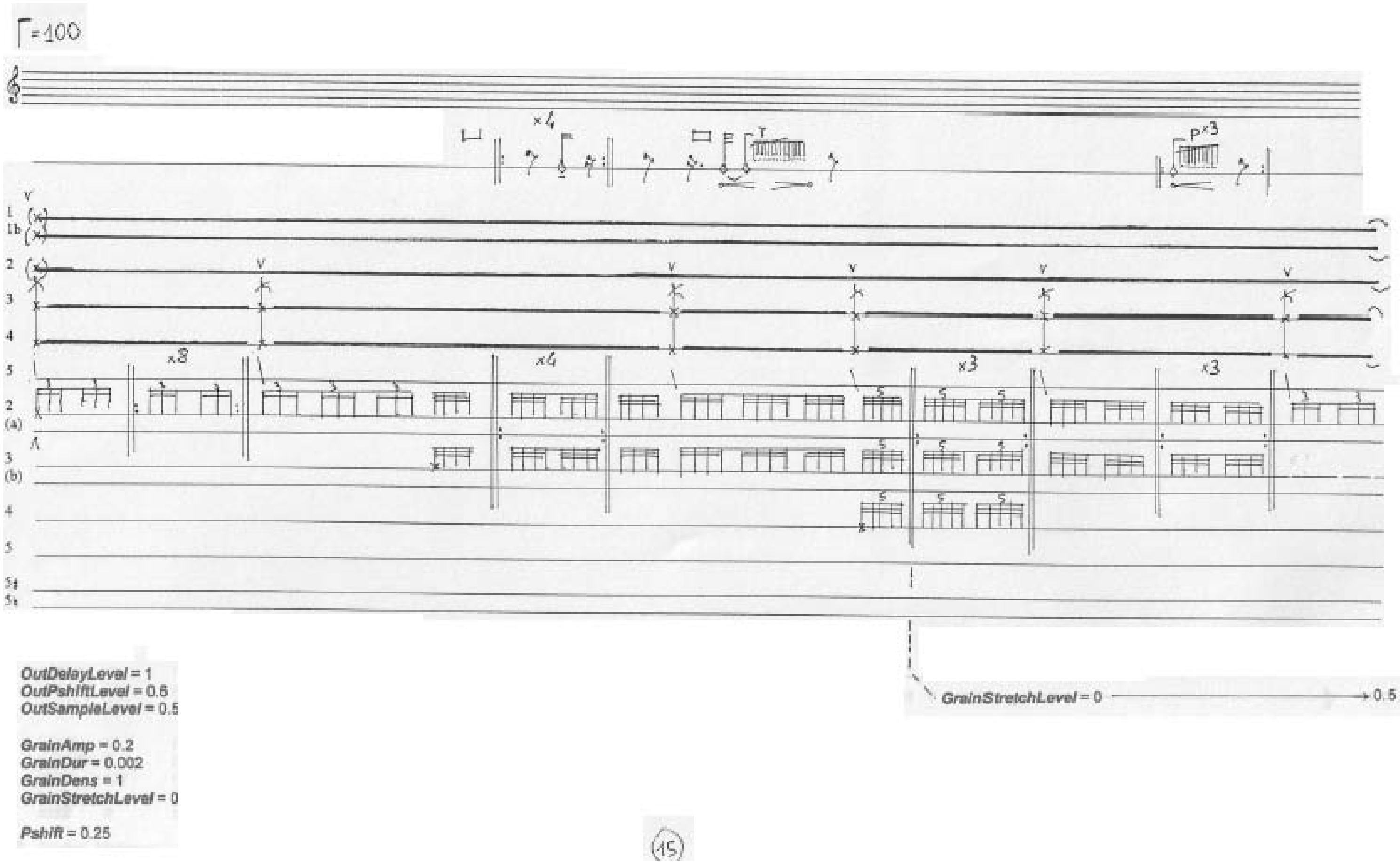


drives the amp scale in the input signal directly to output; **amp-to-amp** mapping is $(0,1) => (1,0)^2$



scales down grain density (in the granulating process) when input is loud
amp-to-dens mapping : (0, 1) => (25, 0) (max 25 grains overlapping at any time)

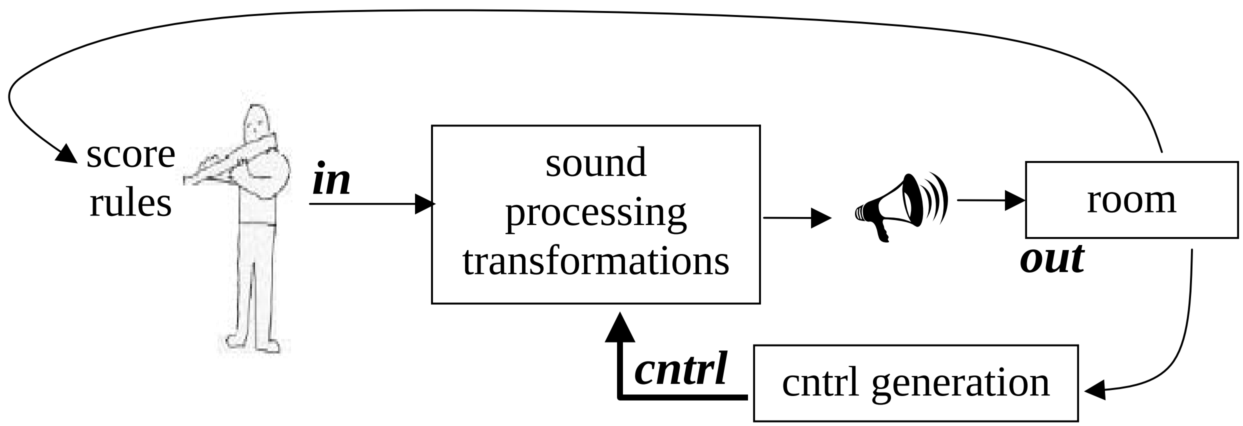
BOOK OF FLUTE DYNAMICS, Chapter 4, page 1



(a page of the *Book of Flute Dynamics* manuscript score). Finger and mouth actions are notated separately, pitch is left indeterminate (depends on finger-mouth interaction, and of the kind of flute utilized). At the bottom of page, the values of manually-controlled variables in the signal patch.

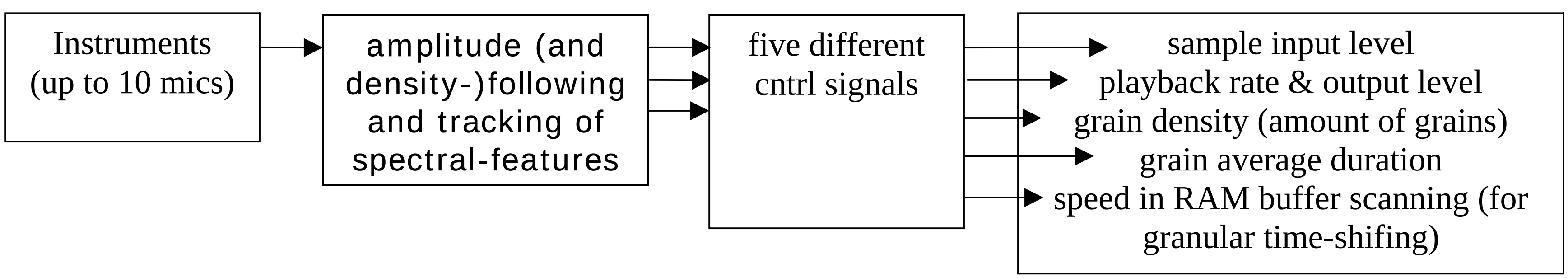
TEXTURE-MULTIPLE ensemble (6) and live electronics (room-dependent processing)

room-specific processing transformations (+ feedback at performance level, using rules for playing that makes instrument performance depend on perceived sonic properties in the output from the electronics)

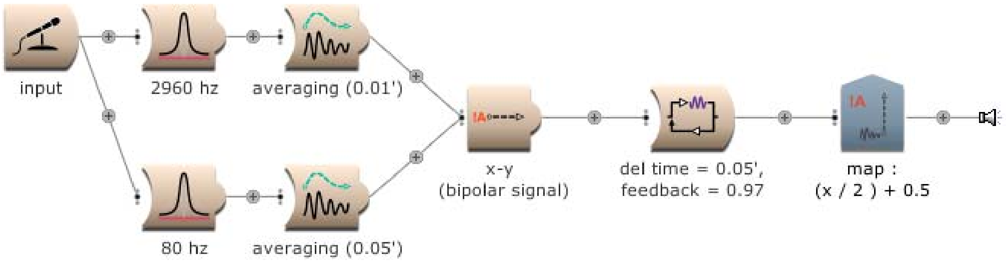


$$out = f\,(in, cntrl)$$
$$cntrl = f(in)$$
$$in = f(out, rules)$$
$$score\ rules = f(out)$$

role of musical score: repository of sound materials <u>AND</u> rules for the instrumentalists to play with them; playing varies with the variety of sound transformations achieved by the computer, and the room response (as rendered in control-signals) drives the computer transformations. Human relationships (i.e. among instrumentalists) are mediated by the technology (computer processing), and the latter are mediated by the room hosting the performance.



some of the cntrl-signals implemented for *Texture-Multiple*



two very narrow bandpass filters track the energy in the input signal (microphones placed in the room) at 2960 Hz (≈ F-sharp) and 80 Hz (≈ E-flat). Two amp-followers track down the response of those two filters. The difference between the two responses is the feature actually tracked down here. So this is again **amp-to-amp** mapping, but we are actually tracking down specific **spectral properties** in the room sound. The signal is then passed through a delay unit with feedback and finally properly mapped to be used as a control signal.

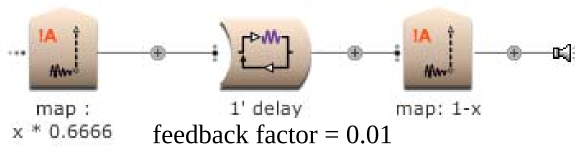
The linear mapping is [-1, 1] => [0, 1] (bipolar range is made positive and normalized). There, 0 = strongest energy is at 80 hz, 1 strongest energy at 2960 hz. This signal drives the playback rate in a sample&playback process to which the incoming sound material is subjected. The actual mapping is a direct linear function, [0,1] => [130,650] hz, where 0.5 = 260 Hz = same frequency as the original material. A prevalence of energies at 80 Hz, will make then the spectrum of the sampled material to be downshifted (down to an octave lower), while a prevalence of energies at 2960 Hz will make it shift up (up to one-octave-an-half higher).

tracks the amount of energy at 739 hz (F sharp) in the room sound. The map is linear but with ranged reversed [0,1] => [1,0].

This dynamically scales the signal entering or recirculating into the RAM buffer (for sample&playback, and granular processing). That way, when the room sound has energies peaking at the given frequency (the instruments often play that F-sharp in this piece), the signal that gets written into the RAM is attenuated, so not too much of that sound will be eventually played back and granulated. That is also to inhibit too strong a systemic resonance between the instrumental material and the room, in case the latter reinforces especially that frequency.

tracks the level of the total room sound over relatively large time-windows (0.075'), and scales down the level of the sound input to the sample&playback RAM buffer. The high-pass filter is only needed to prevent the circuit from being biased by low-frequency energy in the room (rumbles, microphone swinging, etc.).

The particular **amp-to-amp** proportion is (0,1) => (0,0.6666). Because the playedback sampled material is again written in the RAM, this cntrl-signal acts as a gate controlling the feedback of a loop (loop length = RAM length), and the max feedbacksound, the factor will equal 0.6666. The stronger the room sound, the longer the instrumental materials played at that time will recirculate in the loop and thus remain subject to further computer processing.



feedback factor = 0.01

same as the latter, but cntrl-signal is delayed 1 second, with a small feedback in the delay unit. However small, the feedback factor causes a slight accumulation, enough to expand the signal to cover the full numeric range [0,1] when input is very strong. Therefore the overall numeric map is [0,0.666] => [1,0].

This cntrl-signal drives the density of grains in the granulators (granular samplers) that read from the RAM buffer. The **amp-to-density** map is : [0,1] => [80, 0] (a max of 80 overlapping grains at any given time). The louder the room sound, the sparser the granular density.

this cntrl-signal also drives the speed in the time-pointers scanning the RAM buffer to get short signal segments (grains) of the incoming sound. The mapping is roughly as follows : [0,1] => [low speed, highest speed]. When the input is soft, the granular process will time-stretch the input material to make portions of it much longer than real (up to 16 times longer, no pitch alteration). When the input is louder, the speed will be higher, and eventually the input material will be shrinked in its temporal unfolding, until it will be shorter than real: when the input is loudest (cntrl sig = 1), there will be no scanning, pointers will stay still in one RAM position, causing the particular small portion of signal to be repeated periodically. However, by the time when the latter is the case, the grain density will be 0, so we don't hear this perfectly periodic sound.

a decrease in density (down to no grains, silence) compensates for an increase in loudness : when the ensemble plays soft, the density will be as high as to let the grains fuse together in a sustained and smooth texture (could result in a kind of reverberation); when the ensemble plays a bit louder, the grains will eventually tear apart, and that creates noise bands around each spectral line of the incoming materials; when the ensemble plays louder and loudest, the granular texture gets even sparser, and eventually vanishes.

such dynamics is implemented here following from the observation that loudness and density are perceptual correlates in textural sonic events (e.g. many natural sounds): a sonority consisting in many tiny sound grains is perceived as louder then one consisting of fewer grains (the grain amp remaining the same). (That also depends on frequency).

The aim for that is not to replicate, or imitate, some natural sound events, but to instill in the performance a dynamics out of which different sonorities may emerge and evolve.

An excerpt of the *Texture-Multiple* score, with instructions to performers

Notation

There is no score, but only separate instrumental parts.

Two kinds of notation are used : (a) bars of average duration 8-12"; (b) conventionally notated bars, all with ♪ = 140.

Dynamics are either global – printed in larger font-size, within a circle, referring to all musical events until next global mark is reached – or local – smaller font-size, referring to specific events. The former set the default dynamics, the latter are exceptions to the default. Global dynamics is always resumed as soon as a local dynamic value is over.

ppp = *as pianissimo as possible*, especially when playing the high F♯ (or G♭) recurring many times throughout the whole composition.

There is no notation for the live electronics. However the present documentation includes a thorough description of the necessary technical set-up (see below).

Playing Rules

Synchronization among instrumental parts is only requested at the beginning of performance (bar 1) and at other times clearly marked **SYNCH**. At all other times, the single parts overlap among them freely, following rules for individual behaviour described below.

Bars with *ritornelli* can may be repeated : the actual number of repeats (2 or 3) is not fixed, but a maximum number is annotated. When no number is provided, bars must not be repeated.

Commas represent rests of indeterminate duration. As a general rule, they should be longer at the beginning (roughly same duration as the bar), and shorter and shorter as performance proceeds. When playing *ritornelli*, the rest is part of the material that may be repeated.

The following rules for individual behaviour apply, depending on one's own subjective perception of the overall sound texture created by the electronics :

- *if* the texture of electronic sounds

  does (or seems to) prominently include sound materials of one's own instrument, or
  is (or seems to be) very dense and loud

  then any one member instrument may

  keep on playing, but a little softer and/or quicker, or
  leave the current bar and move to next comma-rest, or
  leave the current rest (move soon to next bar), or
  keep at - and prolong - rest (refrain from moving to next bar).

- *if* the texture of electronic sounds

  does (or seems to) include no sound materials of one's own instrument, or
  is (or seems to be) very sparse, soft or silent

  then any one member instrument may

  keep on playing, but a little louder and/or slower, or
  prolong or sustain the current bar, or
  leave the current rest (move soon to next bar), or
  keep at - and prolong - rest (refrain from moving to next bar).

As performance proceeds, *individual* rules may eventually bring forth a *collective* behaviour. Then, the separate individuals become an ensemble.

A page from the piano part of the *Texture-Multiple*