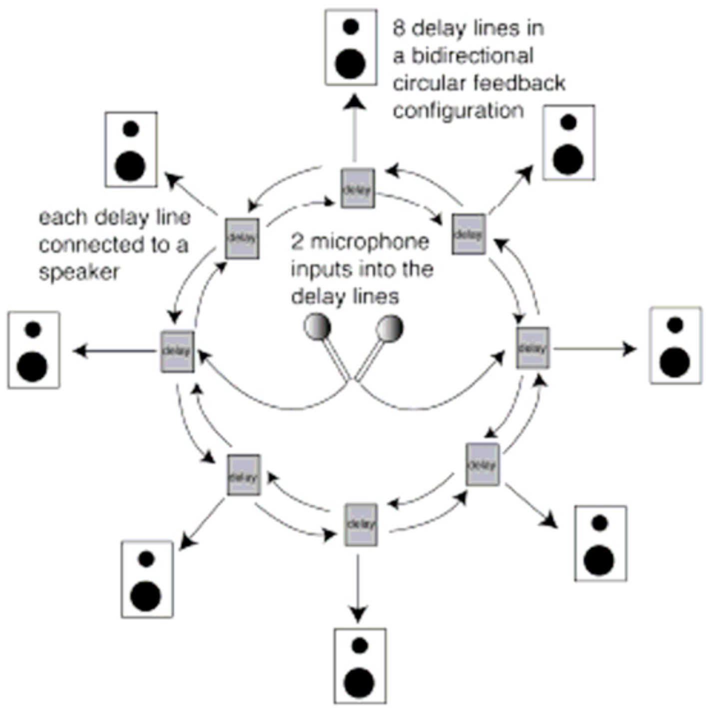
Examples of audio feedback-based works

see instructions to sound installation ***Modes of Interference n.3***
see instructions to **Steve Reich's *Pendulum Music***

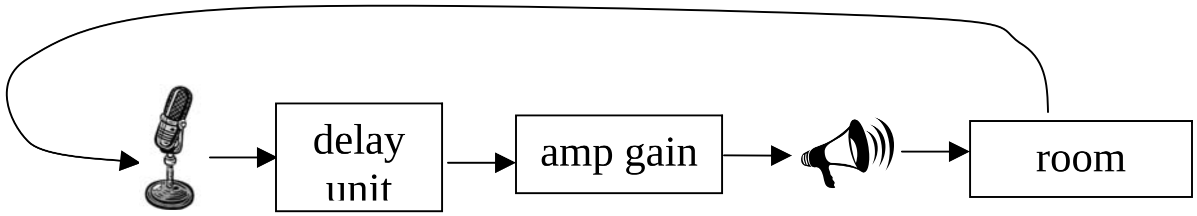
a possible network of mics and speakers:



Each delay line may be given a continuously variable length.

(see C.Burns' online paper, in the Links section of the websit)

what is the effect of introducing some delay into the audio feedback loop?

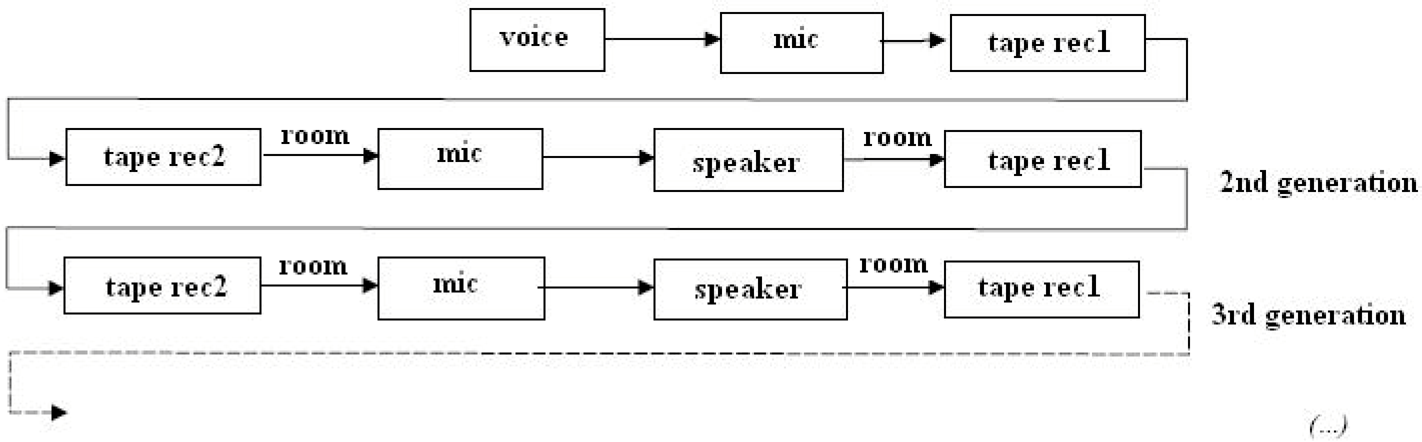


- slowing down the process by which energy in the spectrum gets from extremely sparse (background noise) to extremely concentrated (1 feedback tone, rarely a tone cluster)

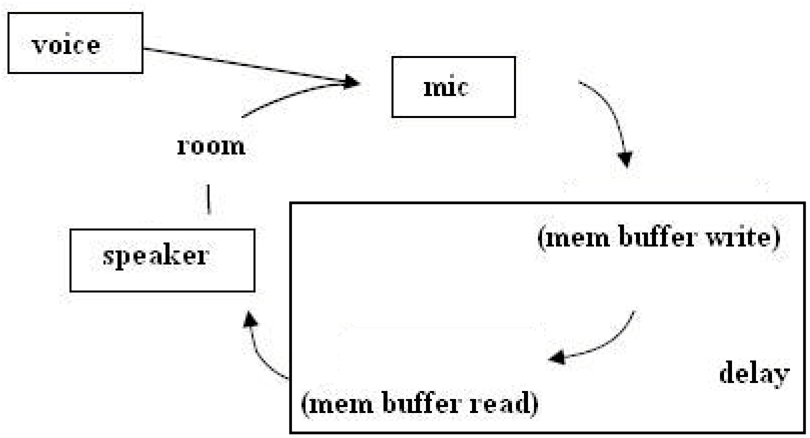
- making the transient phases of this process audible (various resonance peaks build, but eventually only one or few prevail, whose freq is a function of the mic-speaker distance, of room acoustics, of equipment freq-response (nothing affecting sound is neutral to this process)

an exampe of extremely slowed-down feedback process is Alvin Lucier's work *I am Sitting in a Room*

Alvin Lucier's *I am Sitting in a Room*
(see score on the website)



This recursive process of recording the entire speech and playing it back (after speech is over), can be implemented as a real-time recursive process of sampling and delayed playing-back, thourgh the room) (del time = speech duration).



In the jargon of DSP, this is a causal linear process represented as a finite difference equation

$$y(n) = \sum_{k=0}^{N} A_k \, y(n-k) \; - \; \sum_{k=0}^{M} B_k \, x(n-k)$$

More specifically it consists in a IIR (*Infinite Impulse Response*) filter:

$$y(n) = A \, y(n-k) + x(n)$$

a *delay unit with feedback*

where
- $x(1)$ = voice reading text
- $x(n)$, $n > 1 = 0$ (no sound)
- del time = k (duration of text reading, about 70 seconds in Lucier's 1970 LP recording)
- feedback gain = A

in actuality feedback gain depends on two variables, an *output level* and an *input level* (two tape recorders):

$$y(n) = A \, y(n-k) + B \, x(n)$$

when $A/B > 0$, process dies out
when $A/B = 1$, process accumulates causing signal saturation

} → make the whole *system* (equipment + room) a self-observing system, and use the results of self-observation for self-regulation

In theory, the freq response is a harmonic spectrum (*comb* filter) with $f_1 = 1/k = 1/70 = 0.01428571$ Hz

However, input and output are <u>acoustically coupled in the room</u> and the system freq response spectrum is then (in the long run) actually convoluted with the spectrum of the room resonances (convolution = multiplication of spectra).

The room resonances will eventually grow larger than the main peaks in the voice spectrum (repeated ad infinitum, this is a *stochastic* process).

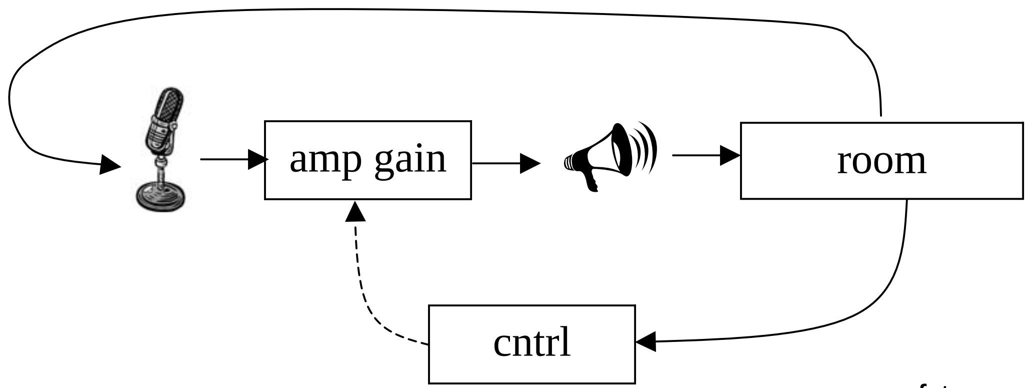
The room acoustics is illuminated by the composition. (Lucier's "each room has its own *melody*")

what if the delay (in the audio feedback loop) changes in time, in the range of millisecs to centisecs?

- feedback control by phase cancellation (& reinforcement)

see the Kyma examples of feedback-control

given a feedback loop whose gain is insufficient to make the accumulation of noise ring (Larsen effect, positive feedback), how can it be pushed to produce sound and to ring anyway?



see use of trumpet in *Modes of Interference n.1*
(check score online)

- increase background noise in the mic, make a resonator (hands, mouth, glass, tubes)
- increase background noise, make some sound

what would be a very good candidate sound, what could make the background noise increase?

- pulse (synthetic)

a pulse train signal = a pulse train spectrum (discrete signal = discrete spectrum)

see sound installation **Untitled 2005**