Agostino Di Scipio

MODES OF INTERFERENCE
2005-06

audio feedback system
with trumpet and electronics

commission ZKM Karlsruhe

for Marco Blaauw

1 performer with

trumpet   trumpet (or flughorn) of any intonation, with at least 3 piston valves
(for M.B.: may be double-bell trumpet with additional valves for microtones)

electronics   2 miniature microphones
2 loudspeakers (minimum)
mixer
computer equipped with ADC/DAC converters, and running real-time digital-signal-processing software (a PD signal-patch can be requested from the composer).

documentation includes :

- a short **INTRODUCTION** to the compositional concept and the process of performance
- description of the minimal **TECHNICAL SET-UP**
- instructions concerning **NOTATION** and **PLAYING TECHNIQUES**
- instructions on **COMPUTER OPERATION AT PERFORMANCE TIME**
- graphical **SCORE** for the performance (2 pages)

In addition, a decription of the **DIGITAL SIGNAL PROCESSING METHODS** is provided, which is needed only if you don't use the composer's own PD implementation.

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INTRODUCTION

This work is a *composed dynamical system*. It is entirely based on an audio feedback loop.

The two ends of the loop are **(a)** a miniature microphone (inside the trumpet), and **(b)** two loudspeakers. In between are **(c)** the instrument (tube with its natural resonances), and **(d)** a signal-processing computer. A very high feedback gain is requested, so the audio loop **(a-b)** builds-up until it results in a howl round, also called *Larsen effect*. The latter usually represents a technical problem in sound systems, but in this composition it is the main sound source. The trumpet and the computer are utilized to play with it, turning a problem into an opportunity. The computer dynamically adjusts the feedback gain, trying to keep the overall system in equilibrium at all times, avoiding Larsen signal saturation **(d.1)**. The overall system remains always subject to fluctuations and perturbations from the environment **(e)**.
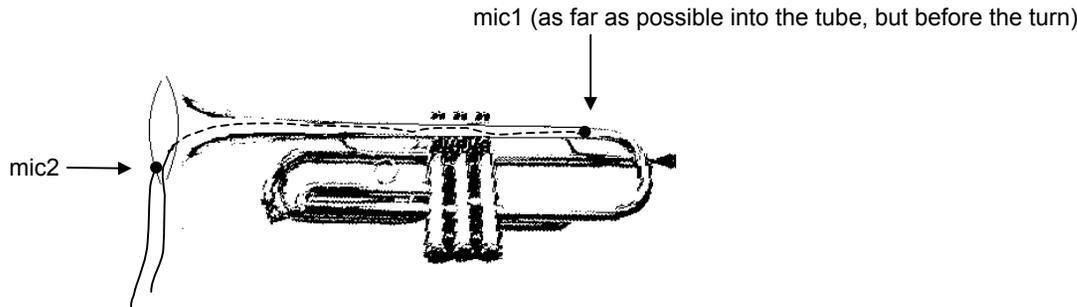
In performance, the trumpet player explores the sonic potential of the audio feedback loop by interfering with it in several manners. Actions on the trumpet are meant **(c.1)** to modulate the resonances of the instrument (valve action makes the tube act like a variable filter internal to the audio feedback loop), and **(c.2)** to introduce noise into the overall system (percussive effects, "breath" sounds, etc.). Both actions change the loop resonances, altering the Larsen tones. The computer transforms and extends all sounds being produced **(d.2)**, and the output of transformations in turn interferes in the feedback loop.
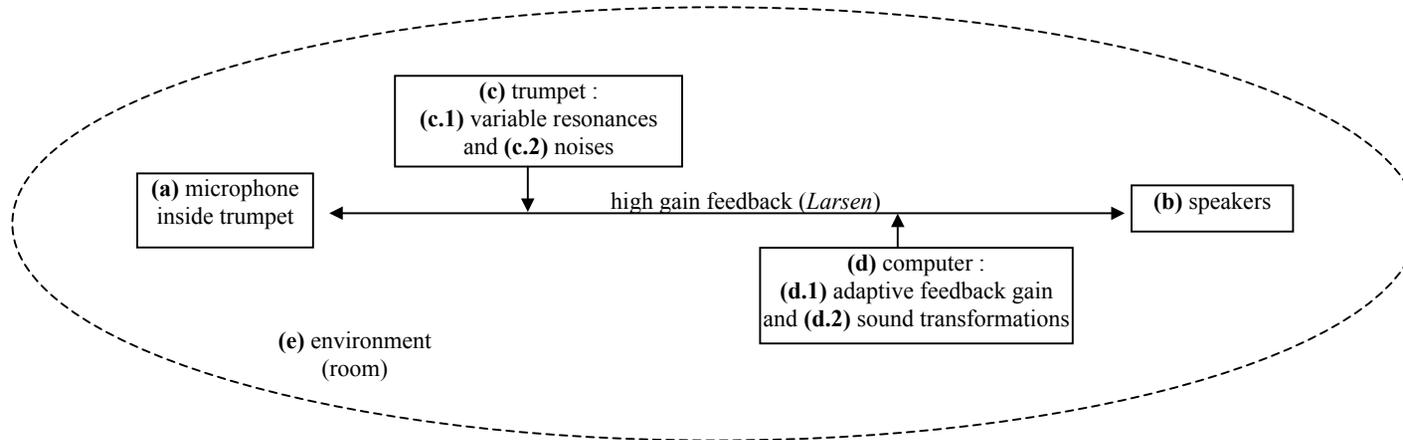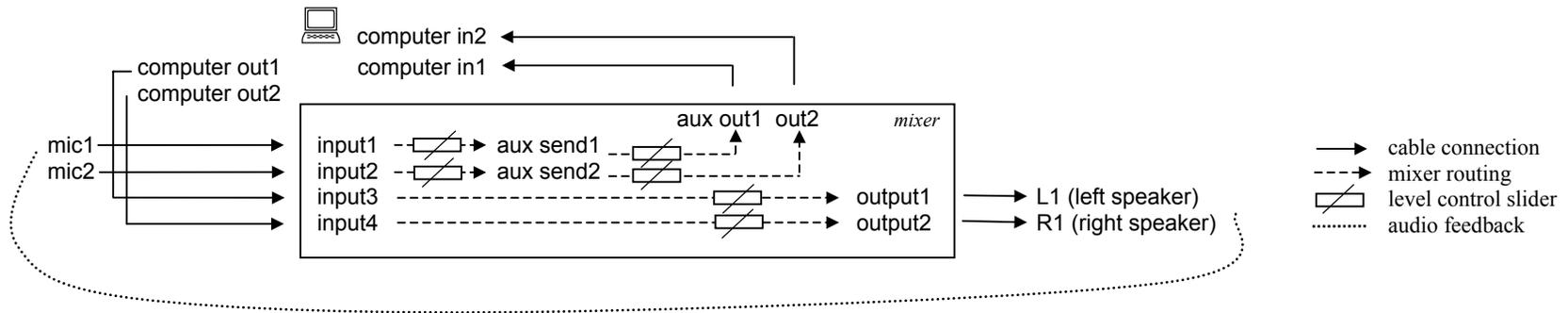
TECHNICAL SET-UP

Microphones

Two miniature microphones must be utilized (DPA…tech specs…), placed as illustrated. Use tape to firmly stick the cables onto the bell's inner surface.

mic1 (as far as possible into the tube, but before the turn)

mic2

Audio Connections

computer in2

computer out1
computer out2
computer in1

mic1
mic2

			aux out1 out2	*mixer*
input1	aux send1			
input2	aux send2			
input3			output1	L1 (left speaker)
input4			output2	R1 (right speaker)

cable connection
mixer routing
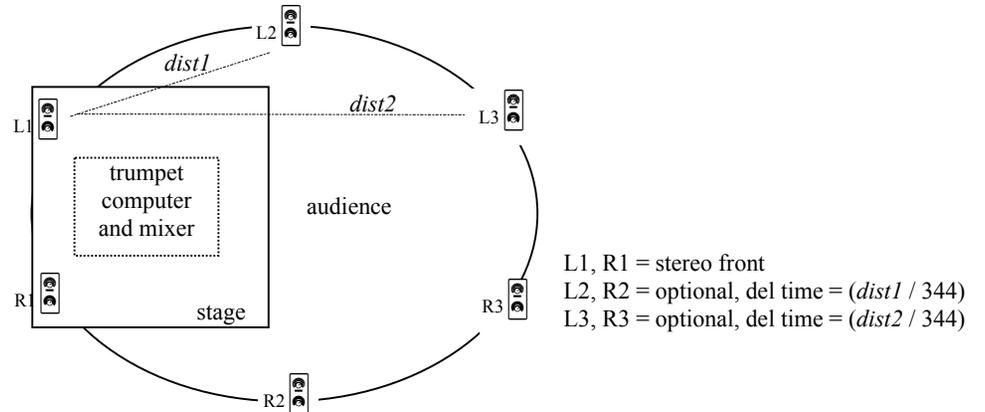level control slider
audio feedback

Sound Diffusion

This work is meant for <u>frontal stereo diffusion</u>.

If multiple pairs of speakers are available, positioned around the audience, they can be used to replicate the front stereo pair, with delays directly proportional to the distance from the stereo pair (delay time = distance / 344). See illustration.

In any case, <u>only the front speakers should be effectively involved in the audio feedback loop</u>.

L2

dist1

L1

dist2

L3

trumpet
computer
and mixer

audience

R1

stage

R3

R2

L1, R1 = stereo front
L2, R2 = optional, del time = (*dist1* / 344)
L3, R3 = optional, del time = (*dist2* / 344)

NOTATION AND PLAYING TECHNIQUES

General Information
The score consists in 32 (+ 1) "time-windows", presenting instructions and/or graphical annotations as to actions to perform in the given duration. Most time-windows have a specific duration. Some don't (denoted by *fermatas*), and last as long as necessary to accomplish the specific task they require.

The whole divides in two parts, which are identical under all respects but valve action (see below). Overall duration is 9-10 minutes.

Valve Action and Larsen
Operating the piston valves changes the length of the trumpet's tube and its resonances. Because of that, when the audio feedback loop (microphone and speakers) generates Larsen, valve action directly affects pitch, amplitude and overall quality of Larsen tones (also the time it takes for the Larsen to arise may significantly vary).

That is the basic and most important playing technique utilized in this composition. No blowing is involved (exceptions are discussed later).

Ideally, every single piston combination would give rise to a different Larsen tone. However, due to several acoustical and technical circumstances which are beyond control, different piston combinations may result in Larsen tones having the same pitch. Moreover, some piston combinations may be Larsen-effective, others may be less effective or even totally idle, insufficent to generate Larsen at all. Beware that during the performance, any given piston combination may be Larsen-effective at some times but less effective or even idle at other times : that depends on the very sound material recircultating in the loop, as well as on changes - however slight - in the distance between microphone and speakers.

Position Relative to Speakers
On stage, find a position relative to the speakers which allows the feedback loop to create Larsen. Small displacements of the instrument - and of your own body, too - affect the length in the feedback loop, and also alter the acoustical shadows and resonances in the surrounding of the instrument. That offers an additional chance to play with the audio feedback loop, and may help you varying the pitches arising from any one single piston combination. All movements should be very subtle and discreet, never overstated.

Piston Combinations and Labels

The notation prescribes *what pistons you can play with* to interfere with the feedback loop. It leaves to you the actual order and timing of all action, except that a minimum rate of change is explicitly indicated.

The fundamental piston position (= no piston depressed) represents a *default* Larsen-generating position that can be used any time throughout the performance. When testing the technical set-up, make sure that position actually lets Larsen tones to arise.

The label **FUND** is used to refer to the fundamental position. Labels listed below are used for other piston combinations, using 1, 2 or 3 pistons. **H** means that pistons must be *half-depressed* (= any intermediate position). **F** means that pistons must be *fully-depressed* (= all the way down).

The following labels are used in the first part of the work, and refer to the piston combinations graphically depicted :

1.H = any combination with 1 half-depressed piston, + **FUND**	=	τTT	TτT	TTτ				+ **TTT**
2.H = any combination with 1 or 2 half-depressed pistons, + **FUND**	=	τTT	TτT	TTτ	ττT	τTτ	Tττ	+ **TTT**
3.H = any combination with 1, 2 or 3 half-depressed pistons, + **FUND**	=	τTT	TτT	TTτ	ττT	τTτ	Tττ	τττ	+ **TTT**

1.F = any combination with 1 fully-depressed pistons, + **FUND**	=	_TT	T_T	TT_				+ **TTT**
2.F = any combination with 1 or 2 fully-depressed pistons, + **FUND**	=	_TT	T_T	TT_	__T	_T_	T__	+ **TTT**
3.F = any combination with 1, 2 or 3 fully-depressed pistons, + **FUND**	=	_TT	T_T	TT_	__T	_T_	T__	___	+ **TTT**

The following labels are used in the second part of the work :

M1(**H** or **F**) = valve action as relative to any musical excerpt where 1 piston at a time is used, + **FUND**. Pistons fully- or half-depressed.
M2(**H** or **F**) = valve action as relative to any musical excerpt where 1 or 2 pistons at a time are used, + **FUND**. Pistons fully- or half-depressed.
M3(**H** or **F**) = valve action as relative to any musical excerpt where 1, 2 or 3 pistons at a time are used, + **FUND**. Pistons fully- or half-depressed.

The phrase "any musical excerpt" means

    - select *any passage of existing trumpet music* (of any style, from any time in history) where <u>only</u> the prescribed number of pistons is used; or
    - select *any musical scale* (diatonic, chromatic, microtonal, or else) where <u>only</u> the prescribed number of pistons is used.

Only the pattern of piston combinations is relevant here (more details on that in the score, Part 2). Pitches actually heard have nothing to do with the musical excerpts adopted, as they emerge from the interference of valve action with the audio feedback loop.

Examples :

2.F [< 6"] = *explore combinations with 1 or 2 fully-depressed pistons; hold each piston combination for 6" or shorter*

M2.H [< 4"] = *explore combinations with 1 or 2 pistons as found in any passage of extant trumpet music or any musical scale: depress pistons half-way down, and hold each combination for 4" or shorter*

1.H+3.F [< 8"] = *explore combinations with 1 half-depressed piston, and combinations with 1, 2 or 3 fully-depressed pistons; hold each for 8" or shorter*

Extra Valves
When using an instrument equipped with more than three valves, all of the above applies as is. However, you can operate one or two extra pistons at any given time during the performance, at your will.

OTHER PLAYING TECHNIQUES

Valve Clicks
In usual trumpet playing, valve action (depressing and releasing pistons) is typically done silently, avoiding or minimizing any audible by-products of the valve mechanics. That's the case with long passages of the present work, too - but *not* with the whole work. In many time-windows valve action has to be made clearly audible, by deliberately causing or emphasizing the click-noise when operating pistons. Clicks eventually affect the resonances, both inside the tube and in the overall feedback system, with repercussions on Larsen tones. Also, clicks are transformed and/or extended by the signal-processing into textural or rhythmical materials.

Trills
Should possibly be introduced only with Larsen-effective piston positions. Use any number of pistons to make a trill, not necessarily depressing the piston(s) all the way down, but only to the point where it audibly affects the audio feedback loop. Speed is free.

You may freely introduce trills, even if not requested, whenever very loud Larsen tones arise, as a way to control and decrease their amplitude.

these require playing the mouthpiece with fingers

Mouthpiece Taps
- one or more fingers gently tapping on the edges of the mouthpiece's cup, covering the cup either entirely or partially. The sound has a clear pitch, depending on tube length. It may reinforce harmonic frequencies in the audio feedback loop, with repercussions on Larsen tones. It is transformed and/or prolonged by the signal-processing into textural or rhythmical materials.

Mouthpiece Scratch
- one or more fingers scratch hard against the edges of the mouthpiece's cup. The sound is an intermittent noise, somewhat pitched at the frequency relative to the tube length. It may reinforce harmonic frequencies in the audio feedback loop, with repercussions on Larsen tones. It is transformed and/or prolonged by the signal-processing into textural or rhythmical materials.

these require that you bring your lips to the mouthpiece. Do not press lips hard against the cup (pressing them hard, may alter the feedback loop).

Breath ("breathing" sounds)
- blowing-out with <u>minimal air-pressure</u>, always with <u>lips apart from one another</u> (to avoid reed-like action).

Whistle ("whistling sounds", random pitch, but very high), coming in either of two variants :
- blowing-out, with heavy air-pressure and somewhat tensed lips
- blowing-in or -out, with variable air-pressure, while leaning the upper teeth against lower lip.

TongueSlap (single)
- the tongue impacts hard against teeth and palate. Blowing-out.

PulseTongue ("tonguing", multiple slaps)
- short sequence(s) of rhythmically-delivered small tongue-slaps, against upper lip and/or teeth. As fast as possible. Blowing-out, or no blowing at all.

TK (or **TKT**)
- usual "double" (or "triple") tongue action. The one you can play the fastest should be preferred. Blowing-in or -out, or no blowing at all.

Do *never* clean the tube during performance : allow the sound of tiny water-drops to enter the audio feedback loop.

DYNAMICS

The notation of musical dynamics is relative to specific playing techniques, so it does not refer to the overall sounding result. Total amplitude may vary, depending on interactions between overlapping playing techniques, as well as on Larsen tones arising and overall feedback system behaviour.

ppp should be understood *as pianissimo as possible*

mf and *f* should be understood *almost mezzoforte* and *almost forte*

Beware that - because of the microphone inside the trumpet - the amplification gain level is alwyas rather high : every tiny event of sound inside the trumpet will be largely boosted. You must keep yourself very attentive and refrain from playing loud. That is especially the case with techniques needing some blowing ("breath", "whistle") and with tongue action (slaps, pulsed tonguing) : these will be very loud even when you play *ppp*.

The overall *crescendo* forks (bottom line of notation) only illustrate how the average total sound level increases, following average density of events and complexity of sound texture, across time spans of approximately one minute : when a peak is reached, density starts again from a lower degree and starts increasing again.

Graphical User Interface (GUI)

The following refers to the GUI displayed on the computer screen at performance time, and illustrates how you operate on that. The particular GUI layout is specific to the composer's own implementation of the internal digital signal processing. Any implementation other than the composer's own will have a different GUI layout, still the featured controls should be of the same kind and should anyway have the same functions as described here.

Once all audio connections are in place and the computer is ready for use, you launch PD (the open-source programming language for sound design). Select and open the **MODES.pd** signal patch. The following GUI appears on the computer screen :
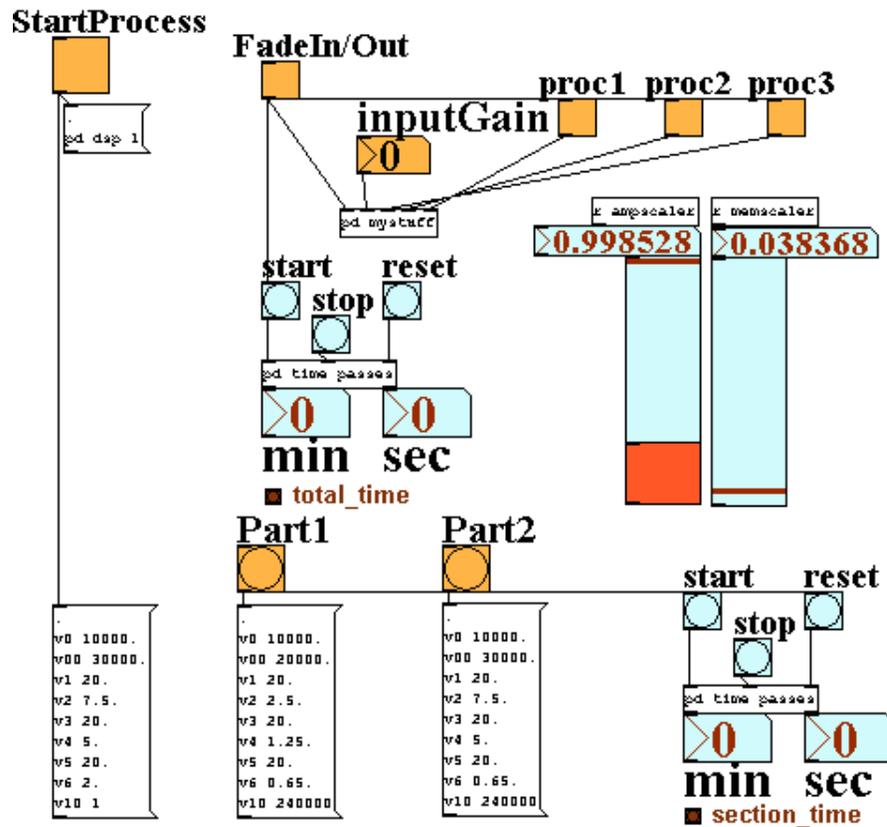
Operations Required

All action is limited to the top-most icons (orange-coloured), and is clearly invoked in the score. Here a short description is provided of the musical function of actions requested.

(1) Set **inputGain** (just before performance begins)
You have to set the **inputGain** value, replacing the default value (0) with a value high enough to let the feedback loop generate a Larsen tone, heard as a continuing tone of rather constant amplitude, or at least without significant fluctuations.

Testing and fixing the effective value for **inputGain** must be done at rehearsal time, with all pistons released (fundamental position) and the performer standing in the same position where he or she will be performing. Effective value may vary depending on many acoustical and technical circumstances.

(2) Click **StartProcess** then click **FadeIn/Out** (time-window #0)
The audio engine gets started. Buttons **proc1**, **proc2** and **proc3** become automatically active. Trumpet performance can start now.

(3) Click **Part1** (time-window #1)
Starts the audio processing specific to the first part of the work.

(4) Click **Part2** (time-window #17)
Starts the audio processing specific to the second part of the work.

(5) Switch-off the **FadeIn/Out** toggle (time-window #32)
The total sound fades-out (this may take some seconds).

Although not meant for direct operation in performance, **proc1**, **proc2** and **proc3** may be also operated anytime during rehearsals or sound-check, to switch three different signal-processing transformations on and off. Similarly, you may want to click **FadeIn/Out** to switch the audio on and off, or you may need to change the **inputGain** (very cautiosly) anytime that seems to be the case.

Information Available in the GUI

Two timers are featured (cyan-coloured). One ("total_time") starts automatically when you click **StartProcess**. It shows the time elapsed since beginning of performance. The other ("section_time") starts and resets when you click either **Part1** or **Part2**.

Two sliders are also featured (cyan-coloured). They start moving as soon as you click **StartProcess** and keep doing so, incessantly, all through the performance. Their current value reflects the current amplitude of input sound material. The right slider is roughly *directly* proportional to input amplitude, the left is *inversely* proportional.

> The left slider is specially helpful. It represents the dynamical factor that scales down the input as the input's own amplitude increases. Because of that, feeble input sounds will be boosted and, conversely, powerful ones will be scaled down and weakened. This adaptive balancing over the input level influences the total output sound too (not only the Larsen sounds, but also the signal-processing tranformations) : the output becomes weaker as the amount and density of sound material recirculating into the loop gets larger - and viceversa.

> If the left slider moves closer to the bottom and enters the red (= input sound is really loud), the output gets so weak it almost disappears. You will learn to avoid that, avoiding feeding too loud sound materials, or temporarioly avoiding to add any sound at all (e.g. you may temporarily refrain from delivering new sounds - if you were so doing - or you may shift to a piston combination not particularly good at generating Larsen - if Larsen sound are currently peaking).

A Note on the Computer-operated Sound Transformations and their Relationship to the Trumpet Performance

The real-time sonic transformations include three different layers of re-sampling of the input sound materials, also changing their pitch and stretching their duration. The results may vary considerably, The result of tansformation is heard sometimes as a prolongation of input sounds, sometimes as strands of pulsed materials randomly scattered in intricate textures, or more rhythmically patterned.

It is relevant for you, that some transformations (not all) are driven by some nuances in the trumpet performance - namely, the dynamics and *density* of sounds (density = rate of events delivered).