SEAM PROJECT - SUSTAINED STEREOPHONY

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ABSTRACT

After decades of sound and music technology development, the everyday practice reveals one of the first walking dead: the stereophony. In a bit more than a hundred years from its birth, the stereophony is not only at the end of its comprehension but also at the end of its necessity. The electroacoustic literature has constant focus, through history, to the listening. Listening as a starting point of thinking, as a background of composing, as a long-distance perspective. Nowadays we actually know better than Blumlein (one of the stereophony's fathers) itself how people listen and how ears and brains do what they do. What we lose versus Blumlein, is the necessity of listening, of reproduction and of listening of reproduction.

Sustaining the electroacoustic literature, the repertoire, means to sustain the necessity of some concepts and their related and consolidated practice, to the perspective of development or, at least, the surviving of comprehension.

1. INTRODUCTION

Sustained Electro-Acoustic Music is a project inspired by Alvise Vidolin and Nicola Bernardini's article [1] on *live electroacoustic music sustainability*. The main ambition of this project is to grow the interpretation and the electroacoustic musical practice with the consciousness of the electronic and informatics problems that had made arduous to approach this music and prevented the growth of interpretative thinking. It is possible, with a community structure, to determine, build and stratify interpretation of musical core, the repertoire, concealing the environment-related technological issues. They are instruments, not the music itself, after all. These are the SEAM organisation coordinates:

- http://s-e-a-m.github.io
- http://seam-world.slack.com

2. PROBLEMS

Why a project about sustained electroacoustic music must focus on stereophony issues? The literature and the repertoire survive thanks to the community activities. Most of those activities require education, strong education about sound and musical matters, layered, from roots to top floor of knowledge. Especially the roots, the elementary concepts, the etymology of the basic lexis, are the most fragile and most violated places of knowledge, where stereophony, one of the keywords of the sound realm, just before to lose its meaning is still losing its necessity.

When the words no longer point the meaning of themselves, we lose (with the meaning), also the reality we used to refer to. The transition from the age of mechanical reproduction of reality, through the history of attempts to reproduce it up to the virtual reality, must pass through, preserving and sustaining, that concepts which have defined the necessity of reproduction.

Speaking about stereophonic sound in music classes should be a keynote, at each level of learning. It should be a moment in which by simple words, simple by the different level of learning, people can understand how they listen, how they also understand the sound reproduction meaning of something real, where per real we focus at least on what we perceive and able to describe, like about the sound. So, in music, speaking of listening and stereophony must be a grade zero of comprehension and knowledge. How it could happen if the explanations about sounds, reproduction of sounds and stereophonic sounds are the following?

> È bene chiarire subito la differenza fra il concetto di "mono" e quello di "stereo". Mono è un termine che deriva dal greco e vuol dire ≪solo≫, ≪formato da uno solo≫. Nel campo audio si definisce mono un segnale che viaggia su un solo canale; esso è costituito da una unica onda. Si definisce Stereo una coppia di segnali audio aventi delle differenze anche minime fra loro, che viaggia su due canali indipendenti: il canale sinistro e il canale destro; il segnale stereo è pertanto costituito da due onde [1]. [2]

. . . and many greetings to Blumlein.

So the question is: which electroacoustic realm could be based on these explanations? And the clear answer is the one we internationally have right now. The same one that totally ignores the loss of the necessity of listening with both ears. The most music, audible during electroacoustic concerts and live interactive performances, in particular

[1] It is good to immediately clarify the difference between the concept of "mono" and that of "stereo". Mono is a term that derives from the Greek and means "solo", "made up of just one". In the audio field, a signal that travels on a single channel is defined as mono; it consists of connected wave. Stereo is defined as a pair of audio signals having even minimal differences between them, which travels on two independent channels: the left channel and the right channel; the stereo signal consists of two waves. (The Book here cited is the most adopted by Italian Musical High School)

the one made with high technological and advanced sensors and interactive features, easily does not focus at all on how people will listen to the performance itself. At the question "*which is your music staging plan?*" the most diffused and the worst answer is "*stereo*". The worst, because it is untrue, considering the fact that they do not actually know what they are saying and doing.

The complementary of missing two-ears-attitude in the electroacoustic domain is the persistence of works that not have the necessity of audience, of auditorium neither. We do not even know who is the chicken or the egg, we only can underline the bond of them.

Nevertheless, the authors [2] of the aforementioned text, claim in their preface, the necessity of a didactic book, a text to take on during the early stage of music technology learning.

They are full of interpretations to allow oneself to follow the unstoppable urge of writing books for young students, instead give them *The Gift*, the best instruction to be passed to people who caress the roots: searching for the meaning from literature sources and encyclopedia. [2]

So, to argue our point, why they focus on greek etymology of *mono*, *alone*, and not of *stereo*, from greek *stereos*, *solid*? Maybe because it means not a number, not a configuration, only an adjective: *solid*, *firm and stable in shape*, *having three dimensions*. *Solid*, from Latin root of *solidus*, *sollus*, *entire*. We also prefer to underline that *mono* is the nickname for monophonic, with the bond between *monos* and *phonē*: *one voice*, *alone*. The same word used in a Gregorian chant description, later evolved in polyphony (from Greek *poluphōnia*, from *polu*, *many* and *phonē*). So the dichotomy, if must be one, between monophony and stereophony simply does not exist. The extension of monophony concept is the polyphony. Stereophony is simply another concept.

With the word Stereophony we should describe a condition by which a *Phonē* (*voice*, *sound*) arrival *solid* to the listener, *whole*, *firm and stable* in their multidimensional sound shape, even in its electroacoustic reproduction with any necessary number of channels.

The path of this journey in the middle-earth of stereophony wants to lead to an understanding of the complexity and unsolved issues around electroacoustic sound reproduction. It is not a text on a new approach to something, rather it is an old something to be re-assembled, to be re-read, a path to seam and bond of different ideas appeared in our history of music, to which we, musicians, must be referred when staging music. The journey will not complete itself. The path will not lead somewhere. The real sustaining of electroacoustic music will start only with the death of the ready-to-listen recipes approach. When listening and speculation on music and sound will come back fashionable.

[2] The Italian Treccani encyclopedia at `http://www.treccani.it/enciclopedia/stereofonia/` explain with universally-simple words what humanity, without allowing personal interpretations, should refer with stereophony words. It is free knowledge, for Italian speaking people, not overwritten-able. We ironically even must sustain the use of the encyclopedia.

3. ROOTS

The healthy mental attitude to sharing knowledge forecast the roots to knowledge and sharing, even without interpretations, they could be afforded later.

> An observer in the room is listening with two ears, so that echoes reach him with the directional significance which he associates with the music performed in such room. He therefore discount these echoes and psychologically focuses his attention on the source of the sound. When the music is reproduced through a single channel the echoes arrive from the same direction as the direct sound so that confusion results. [...] Human ability to determine the direction from which sound arrives is due to binaural hearing, the brain being able to detect differences between sound received by the two ears from the same source and thus to determine angular directions from which various sounds arrive. [3]

With those words, Blumlein [3] described the fundamentals of at least two huge arguments: how we perceive acoustic sounds and how we had reproduced sounds until that moment to be listened and perceived.

The human binaural listening is the first statement of Blumlein conception: "*an observer in the room is listening with two ears*". How this listening condition evolves during the time is the peculiarity of stereophony. It is not related to the number of sources, not even to the number of microphones and loudspeakers necessary to reproduce that condition. The technique and the aim of the chosen technique will focus to solve more topics possible to fulfill that condition.

Is a single human voice speaking, a monophonic voice inside a small room, an acceptable stereophonic condition? In agreement with Blumlein, Yes! This is the first firm point.

Michael Gerzon, from the seventies until the nineties, from the roots of the Blumlein's era jumped the line with dozen of clear descriptions about perception and attempts to design technologies of reproduction to accomplish the gap versus acoustic realm.

> The ears and brain localize sounds according to many different mechanism. Among the most important cues used are low frequency interaural phase (applicable up to around $2KHz$, but dominant below $700Hz$) and localization by amplitude differences between the two ears, predominantly above about $1KHz$. While other cues are also important, we have found that satisfying both these cues, and making them mutually consistent for central listener facing in any direction, leads to particularly robust and reliable localization quality. [4]

4. BRANCHES

With the deep knowledge of time meaning between us and Blumlein, we can expose loudspeaker significance better than him. For the Blumlein era, the loudspeaker was the future instrument for a better present time. The reproduced sound, at its young age, was pure magic. Today we know well how unsatisfied we are of loudspeaker reproduction. When the first iPhone was the only one smart-thing on the planet, it was awesome, an awesome object of crafting. Today with the same object we would not take even a picture. Listening to a violin solo reproduced by the best loudspeaker on the market is not the same experience of the real performance. It is not related to stereophony and technique ability, it is integral to the reproduction limit of the technology we are able to craft.

Replacing the human voice speaking of the example before, with a single loudspeaker speaking the recordings of that human voice we lose, as Blumlein described, the capacity of ears-brain deciphers the sound-environment relationship. It is not more the same stereophonic listening. The numbers of sources are the same. Both of them in their monophonic speaking produce a different listening condition.

In 1992 Michael Gerzon [4] draws a schematic representation of different loudspeakers positions for multispeaker stereo, from one to five:

> ...we show the loudspeaker layouts considered for frontal stage stereo using from one (regarding mono as the trivial case of "one-loudspeaker stereo"!) to five loudspeakers...

Is there a one-loudspeaker stereo condition? Truly yes.

A loudspeaker in condition to play itself, not reproducing something of acoustic real but *producing* a sound that not could live without a loudspeaker, represents a stereo condition with general characteristics similar to the speaking voice. A Butterworth filtered pink noise monophonically singing in a room is a condition of stereophony.

For an electroacoustic musician, the loudspeakers are instruments. Choosing loudspeakers, knowing their character and their characteristics is a necessary moment for that musician. Knowing their character requires time. Manually changing the frequency of a sinusoidal sound reproduced by a three-way loudspeaker, at one meter of distance, with the ears at the same high of the loudspeaker center, is a good way to say Hello! at the loudspeaker. The musician will discover in this way that the sounds produced by the loudspeaker will change their shape during the sweeping. Near the crossing point of the crossover maybe He will find some peculiarities, some other strange phase decorrelations at very high frequency. The loudspeakers are instruments. Two loudspeakers could be the minimum set for the stereophonic condition of listening. They could be polyphonic electroacoustic singers. They also could be a monophonic condition, when stereophony or polyphony are not required.

5. SEAM INSTRUMENTS

During the lessons in Rome's Conservatory of Santa Cecilia in which *SEAM PROJECT* was born and its related problems were shared with classes to sensitize students to community work, the core software used to explode issues was *Faust* [3]. This wasn't a restriction, it was a preference. Text-based DSP offers the deepest learning experience and great expressivity and readability. *Faust* code could be written to educate a musician at the same time with computation versatility and efficiency. The *Faust libraries* concept is useful to focus on write once, and read forever, code. We think *Faust* itself represents a rather concept of electroacoustic sustainability. Thinking, for example, at the *filters.lib* and at the names that contributed to the enrichment of the speculation around each object, make us wish to a musical interest capable to create a community more than with the adoption of other software.

Instruments carved by musical ideas on readable text-code becomes a sub-literature in which each brick maintains the power of the source code, the clarity of an equation, the efficiency of the continuous development, the reusability of a word in many different contexts.

The *SEAM library* local importing points to other libraries catalogued by arguments, like in *Standard Faust Libraries* [4].

```
1 import("stdfaust.lib");
2 import("seam.lib");
```

6. MID-SIDE

> In this electrical era one is not surprised to hear that orchestral music can be picked up in one city, transmitted a long distance, and reproduced in another. Indeed, most people think such things are commonplace. They are heard every night on the radio. However, anyone who appreciates good music would not admit that listening even to the best radio gives the emotional thrill experienced in the concert hall. [5]

With these words, Harvey Fletcher introduces one of the milestones articles in the story of stereophonic sound, even perception. Physicist, his name you can find tattooed, on the left chest, of each true-stereo sound engineer.

Today we lost each sparkle of "that electrical era", even the one that held the flame of interest in listening orchestral music through transmission, or the one that held the flame of interest in listening orchestral music, or the one that had interest in listening, of interest. One hundred years after that "era" we are monkeys about listening attitude.

We must consider that failure. Failure of purpose. We must consider that a book, even the most inadequate, as an object of thinking has power, as demonstrated in the introduction, that could be the power to destroy.

In 1964, Paul W. Klipsch introduced the "*Symposium on Auditory Perspective*" reprinting, the collection of articles

[3] https://faust.grame.fr

[4] https://github.com/grame-cncm/faustlibraries

dated 1934 about theatre live music perception and transmission, containing the Fletcher's aforecited:

> The following paper is a reprint of one of the most important papers in the field of audio. Fundamentals do not change. The laws of physics endure. In reprinting the Symposium, the fundamentals are restated. [6]

The Klipsch words point on a direction of encouragement for us: he sustained stereophony through literature significance.

The Fletcher [5] text is dated 1934, one year after the approval of the Blumlein patent that describes the Mid-Side fundamental concept of sound transmission and recording. In that era the business interests and the listening interests were weaved, in a *stereo*, solid, form.

Speaking about ears and brain activities to determining the direction of a source Blumlein wrote:

> . . . it is fairly well established that the main factor having effect are phase differences and intensity differences between the sounds reaching the two ears, the influence with each of these has depending upon the frequency of the sounds emitted. For low frequency sound waves there is little or non difference in intensity at the two ears but there is a marked phase difference. For a give obliquity of sound the phase difference is approximately proportional to frequency, representing a fixed time delay between sound arriving at the two ears, by noting which there is a phase difference of π radians or more between sound arriving at the two ears from a source located on the line joining them: but above such frequency if phase difference were the sole feature relied upon for directional location there would be ambiguity in the apparent position of the source. At the stage however the head begins to became effective as a baffle and causes noticeable intensity difference between the sounds reaching the two ears, and it is by noting such intensity difference that brain determines direction of sounds at higher frequencies. [3]

Blumlein, on the knowledge of the mechanisms above exposed, has formulated most of the basic principles impressed on the history of stereo. The most basic approach to stereo relied on simple level differences at loudspeakers reproduction, perceived as both level and phase differences at the ears. The coincident directional microphone stereo pair technique, closest, with no time delay between channels, was born, the ideal to feed loudspeaker of purely amplitude difference between channels. One of the typical pure coincident stereo techniques takes Blumlein's name: two pure pressure gradient figures-8. Nevertheless, as exposed in patent, the only microphones available to Blumlein in his early experiments were pressure nondirectional microphones. Two, even closest, quasi-spaced nondirectional microphones are able to feed signals identical in amplitude and different in phase. So He focuses on a strategy to craft amplitude difference at loudspeaker from phase difference at microphones. The result was his matrix of sum and difference at the roots of Mid-Side technique.

> . . . a system of sound transmission wherein the sound is receive by two or more microphones, wherein at low frequencies difference in the phase of sound pressure at the microphone is reproduced as difference in volume at the loud speaker. [. . .] two microphones transmitted over individual channels are adapted to interact [. . .] consisting in half of the sum and half of the difference respectively of the original [3]

These are the words explaining the Mid-Side technique we are attempting to celebrate with this path.

The Blumlein matrix of sum and difference between signals is bidirectional. When the Left and Right channel of a stereo pair passes through the matrix, the sum of both channels provides the all in phase Mid signal, while the difference produces the out-of-phase lateral signal. However, when the Mid-Side signals begin to travel across the matrix the sum of Mid and Side provides the positive left phase to amplitude conversion, while the difference gives the right negative phase to amplitude conversion.

Here the three lines *Faust* code for sum and difference matrix.

```
1 nsum = 0.5*(_+_);
2 ndif = 0.5*(_-_);
3 sdmx = _,_ <: nsum, ndif;
```

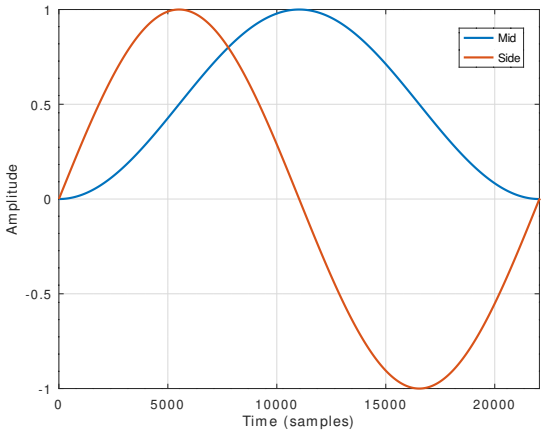

Figure 1. **Mid-Side Panner**. The plot shows the 360 degrees sweep from left -180 degrees to right 180 degrees. The Side (red) line shows the bipolarity of the signal related to the angular information. The Mid (blue) line has only positive energy in relation to angular information. The plot shows the evidence of the zero meaning at both edges of -180 and 180 degrees, where cardioid and figure-8 are hear-less.

7. MID-SIDE PANNER

The following passages will lead step-by-step to the Mid-Side panner developing. First of all, it is necessary to understand the polar pattern significance of a signal. A single signal, in its amplitude variance around zero, could be derived by any kind of microphone without particular meaning. It could be electrically generated by a microphone or another synthetic source without specific relevance. The polar provenience, the shape of the signal phase, becomes relevant to the comparison between signals.

From the Blumlein description of *Mid-Side*, we have a *Mid* frontal channel commonly described by a cardioid microphone. The first-order cardioid microphone could be described as a sum of non-directional pressure (*ndp*) variations

$$ndp = 1(x) \tag{1}$$

and bidirectional pressure gradient variations.

$$bpg = x \cos\theta \tag{2}$$

The first relevant difference between a non-directional polar pattern equation (1) and directional one (2) is the presence of the angular coefficient. The *theta* angle in the equation (2) describes the pointing direction of the bidirectional microphone expressed in radians. The x is the pressure relative signal.

The cardioid (*cpg*) microphone we attempt to synthesize must point to the front-central position that is the zero radians reference.

$$cpg = 0.5(x) + 0.5(x \cos\theta) \tag{3}$$

Cardioid and other first-order most common patterns are produced with the following weight between non-directional pressure and bidirectional pressure gradient:

Polar Pattern	Equation
Omnidirectional	$1(x)$
Subcardioid	$0.75(x) + 0.25(x \cos\theta)$
Cardioid	$0.5(x) + 0.5(x \cos\theta)$
Supercardioid	$0.37(x) + 0.63(x \cos\theta)$
Hypercardioid	$0.25(x) + 0.75(x \cos\theta)$
Bidirectional	$1(x \cos\theta)$

Table 1. *non-directional pressure* coefficient and *bidirectional pressure gradient* coefficient to first order polar patterns description. Where the x is the input signal, the θ perspective angle of incidence

So by the primitive first-order polar patterns, non-directional and bidirectional, we could derive, progressively, each shade of shape between them, angular pointing everywhere around 2π radians.

Finally, the Mid component of the Mid-Side panner could be expressed by the formula

$$m(x, p, \theta) = (p * x) + ((1 - p) * (x \cos\theta) \tag{4}$$

Where x is the input signal, the p is the amplitude coefficient, 0.5 for cardioid purpose, the θ is the angular impact direction expressed in radians.

The Side component is the bipolar figure-8 straight formula pointing on left.

$$s(x, \theta) = x * (sin(\theta)) \tag{5}$$

The Faust code for a Mid-Side panner is truly self-explained: the straight equations to describe both cardioid and figure-8 are the two components at the out of panning.

```
mspan(x,p,rad) = m,s
  with{
    m = (p*x)+((1-p)*(x*cos(rad)));
    s = x*(sin(-rad));
};
```

We must pass the panner through the sum-difference matrix to obtain what Blumlein describes as the difference of amplitude at loudspeakers signals from the differences of phases.

```
mspan_lr(x,p,rad) = mspan(x,p,rad) : sdmx;
```

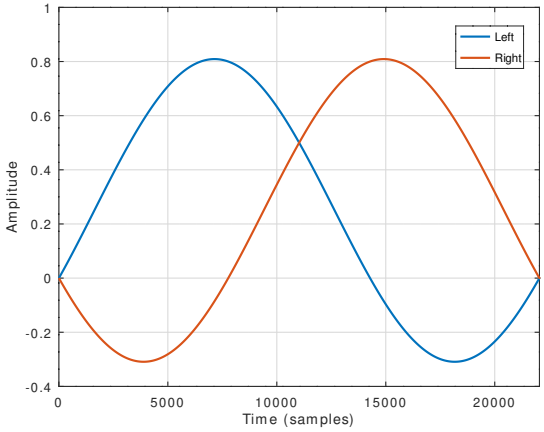

Figure 2. **Mid-Side Panner to Left-Right amplitude**. The plot shows the 360 degrees sweep from left -180 degrees to right 180 degrees. The top amplitude with a cardioid polar pattern for the Mid channel is around 0.8. The 1 amplitude factor is reached when the Mid channel has an omnidirectional polar pattern. The plot shows the negative amplitude at opposite angular provenience

8. MS-PAN LIVE USAGE

The Mid-Side panner here proposed is not only a technical object, useful or not, comparable or not, related to other pan-kind. The Mid-Side panner here proposed is an object of thinking. We use the Mid-Side technique, to reflect stereophony itself; because we strongly think that some circumstances highlighted in previous sections need to be approached, others improved and many others killed.

Thinking about panning must be strongly encouraged because it is a simple object too often used without questioning. People can think that the quadratic panner is better

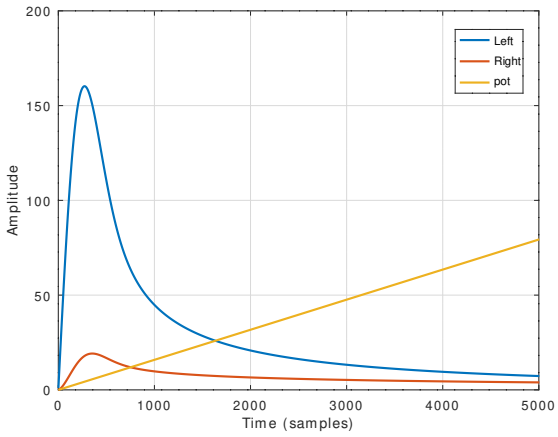

Figure 3. **Left-Right quadratic amplitude panner feedback response**. The plot shows panner response at one cycle of sweep from left to right. The plot shows as amplitude moves fast over 150 times the initial value on the "in-feedback" channel and over 20 times on the "opposite" channel.

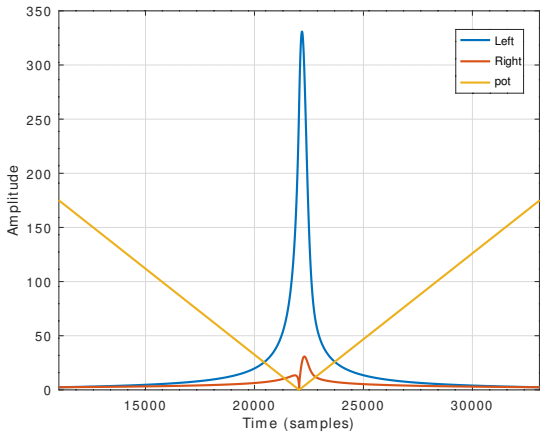

Figure 4. **Left-Right quadratic amplitude panner feedback response**. The plot shows the moment in which the cycle of sweep pass from right through left and again reversing to right. It shows as amplitude moves fast over 300 times the initial value on the "in-feedback" channel and over 30 times on the "opposite" channel.

than the linear one that only by virtue its most recent introduction. But if we stop its "usage without questioning" and, as musicians, we take time to analyse the manual usage of one in place of the other we can feel a difference, practical before sonic.

By knowing them we can analyse the mixer market and the role of panning in mass-culture music. Without analysing these practical issues, it is not really understandable why the worst panning technique ever is the most hardware implemented.

The code to build a quadratic amplitude panner is pretty trivial. The most prolix *Faust* code will do it in five lines. Deleting the $sqrt$ from the following formulas it becomes the simplest traditional linear amplitude panner.

```
lrpanq(x,p) = l,r
 with{
   l = sqrt(1-p)*x;
   r = sqrt(p)*x;
};
```

Where p is the angular coefficient expressed by the potentiometer, in a range between 0 the Left position, 0.5 the Center position and 1 the Right position.

Smiling, it could be done by one line:

```
lrpanq(p) = _ <: sqrt(1-p)*_, sqrt(p)*_;
```

We have explained the path to Mid-Side panning, starting from the roots. Now it is the moment to understand what are the possible usages and what are the peculiarities of a Mid-Side panner instead of the *traditional* amplitude panners.

The *matrixed* signal has its complexity as a disadvantage. Stop. In fact it requires knowledge and fantasy to understand a signal as the significance of matrix combination and it also requires a bit of tricky work more than a straight-signal.

As musicians, even when plots and formulas appear pretty clear, in the end, at the moment of judgment, are the ears and the musical usability to determine the best, personal, choice.

The fascinating realm of *matrixed* signals forces a little to work by thought. So, for us, for example, the phase modulation strength of the Mid-Side panner had suggested, even before a practical test, better stability on live usages. Why? It is pretty simple to demonstrate.

A microphone is routed into a channel, with a mid-lateral pointed panner, suppose 23 degrees to left and fed to the loudspeakers. With the quadratic panner, both left and right channels have different amplitude values with the same phase values. The feedback of the loudspeakers' signals inside the microphone comes from in-phase different energies sources. Searching the feedback with fingers on the gain will produce signals that will increase at least quadratically [fig. 3, 4].

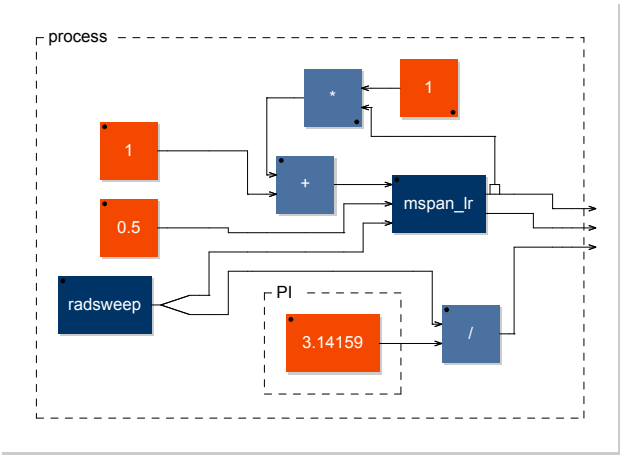

Figure 5. **Block diagram of the infinite feedback**.

On the other hand, in the same feedback situation, with the same angular panning provenience applied to the mi-

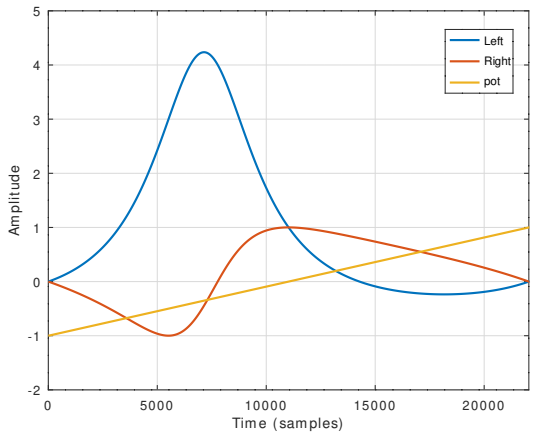

Figure 6. **Mid-Side to Left-Right panner**. The plot describes the feedback response with a pan movement through the entire panorama, from -180 to 180 degrees (yellow line, normalized to -1 and 1). The energy multiplies up to four times for the left channel in infinite feedback (blue line). The top of feedback increasing is at 45 degrees position in direction of the channel in feedback.

crophone signal, the Mid-Side panning will produce different phase and different energy for both loudspeakers. The differences, in air, will produce a more resistive feedback pattern. In other words, the Mid-Side panner act "naturally" as anti-*Larsen*.

9. CONCLUSIONS

This is the second article *SEAM* produces to spread the music sustainability concept [1] from live electronics music to the broader electroacoustic music composition and interpretation. The original issues about music score documentation in electronic music are the fundamental core of the concept. Nevertheless, the focus of this research, and the approach, point to a compositional and practical situation that afflicts not only the documentation of a score but the musical thinking and practice at all.

The research defines a critical educational situation, the first one analysed pretend to overcome literature with a new fancy way of teaching, writing books, in our opinion ludic, to educate like playing. There are a lot of textbooks, didactically introduced at each level of electronic music school, with the "doing, does not matter why" approach. You can pretty simply recognize them, they offer electronic music teaching as a collection of recipes, articulated like a foreign language book. Some authors praise themselves for the didactic unit-based structure of their books, inspired by foreign language learning texts. Is that music? Is music a foreign language? From these gruesome attitudes, the *SEAM PROJECT* wants to take long-distance. What distance? Distance in thinking music and thinking about music, because sustainability is only superficially a technical issue. The documentation is a quality parameter of sustainability but it is the musical practicing and interpreting that will build musical thinking during the years.

The first concept to be clarified in the conclusions is that sustainability must aim at maintaining a musical idea, the peculiarities of a concept is necessary like the peculiarities of the piece of art. We point at sustaining the speculation that music produces, through the sustaining of listening, that we have defined as the *sustainability of the process*.

It is necessary to focus on the main difference between technical sustainability and musical sustainability. Technical sustainability concerns the work, it is linked to the technical world that the work defines. It is its carbon dating, the reproducible ecosystem, maybe, but it is not the work itself. Musical sustainability is a matter of thoughts, that makes use of those tools to go out towards the perceptible. Supporting the thoughts is supporting music, perception, and listening.

> La musica non è solo composizione. Non è artigianato, non è un mestiere. La musica è pensiero [7] [5] .

10. REFERENCES

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[2] G. Cappellani, M. D'Agostino, L. D. Siena, G. Paolozzi, and S. Mudanò, *Laboratorio di Tecnologie Musicali Vol. I*. Contemponet, 2014.

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