EXPLORING DISPARITIES BETWEEN ACOUSTIC AND DIGITAL SOUND OUTPUTS

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Submitted: <leave for Editor to date>

Abstract

Mapping digital sound to an acoustic input enables the performer and the software to "talk" simultaneously. Whilst the performer has direct control over the acoustic outcome, the digital can become a means of destabilization because it is mediated through code. Musical expression substantiates as the performer addresses the unexpected resourcefully. This text describes the performative dynamics in terms of perceptual mechanics.

Acoustic and digital instruments are different in nature. Thor Magnusson defined a very clear distinction [1]. With acoustic instruments the performer yields a physical force to drive the instrument - the interface and the sound engine are one and the same. Electronic instruments are not virtual either, since some of the characteristic sound depends on the chaotic or entropic properties of the materials used. Conversely, the body of the digital instrument is theoretical. The interface and the sound engine exist separately, and there is no natural mapping between the physical input and the digital output: "The physical force becomes a virtual force; it can be mapped from force-sensitive input devices to parameters in the sound engine, but that mapping is always arbitrary (and on a continuous scale of complexity), as opposed to what happens in physical mechanisms" [2].

Since the interface and the body are distinct and the mapping is arbitrary, the control over the digital sound is a matter of choice and feasibility. A survey conducted in 2006 suggests that many musicians seek absolute control over the instrument [3]. Andrew Johnston proposed a different type of interaction, which he named *conversational*: "The musician allows the virtual instrument to 'talk back'… responsibility for shaping musical direction continually shifts between musician and virtual instrument" [4].

Mapping digital sound to an acoustic input enables yet another type of approach. When both acoustic and digital sounds are audible, the performer and the instrument can "talk" simultaneously. One can deliberately explore the disparities between acoustic instruments and digital sound engines. Whereas the immediacy of the acoustic conveys control over the sonic outcome, the digital entails a threshold between the performer's control and the instrument's unpredictability, which can be manipulated so as to convey liveness and expression [5]. The instrument is then simultaneously a "tool" and an entity in itself. An unexpected event can produce compelling performative tension. It causes a minimal, yet graspable hesitation, which the audience senses empathically as *suspense*; resolving the musical challenge then causes a sensation of release.

Many researchers endeavor to maximize the performer's sense of control over the digital sound engine [6]. Magnusson also points out that where the digital instrument exhibits any chaotic or entropic behavior, this tends to happen due to a failure in design, a bug in the code or loose wiring in the hardware. Personally I have direct control over the acoustic output, and I welcome certain unpredictability in the digital output.

The digital outcome is mathematically determined, yet it can be undeterminable, particularly when mapped to an acoustic input. Firstly, the resilience of the acoustic exceeds its codified terms – the digital processing does not handle *all* the acoustic information, based on the inherent limitations of sampling the input. Secondly, the software may consider elements that one is not perceptually aware of, and respond accordingly. The incoming information is processed based on mathematical conclusions. Conversely, humans sample and process the information based on attention, on cognitive principles, and on the cross-sensorial context [7]. One can create complexity and unpredictability with purely rule-based software.

In the 1950s John Cage proposed that uncontrolled features can be used as musical material [8]. Marcel Duchamp's *Erratum Musical* (1913) anticipated by nearly forty years Cage's thinking of how the laws of chance might apply to music [9]. Duchamp created a musical *jeu d'esprit,* Cage explored chance as a compositional principle, and many recent artists explore these compositional approaches [10, 11]. Cage tossed I-Ching coins and Tarot to score many of his pieces. His strong assimilation of eastern philosophies is well known, and these philosophies suggest that suppressing intention is required to permeate the unity and mutual interrelation of all things, which are inseparable parts of a cosmic whole. Cage studied Indian philosophy and music. When he asked what was the purpose of music in Indian philosophy, he received the answer: "to sober the mind and thus make it susceptible to divine influences" [12]. In fact, today one can also speak of a major order in scientific terms. Chaos Theory, the existence of an order underlying apparently random data and/or processes, embraces Karl Popper's "causal chance": "It was only the incompleteness of our knowledge which gave rise to this kind of chance" [13].

Philosopher Henri Bergson (1859-1941) saw intuition as a way to attain direct contact with a *prime reality* ordinarily masked from human knowledge [14]. He described this prime reality as a *perceptual happening*, an ongoing movement, an evolving dynamic flux that proceeds along a definite but unpredictable course. Bergson noted that the human mind is shielded from the perpetual happening by the intellect, which imposes *patterned immobility* on prime reality, separating it into discrete objects, events and processes.

Today we can also describe this 'shielding from prime reality' with the aid of cognitive research. The primary aim of the brain is to detect, perceive and respond to objects and events as efficiently as possible [15]. According to many researchers [16, 17], incoming information transits from *sensory memory* into *short-term memory*, and subsequently to *long-term memory* from where it is constantly retrieved. Whilst *long-term memory* indefinitely stores a seemingly unlimited amount of information, the rapid decay of *short-term memory* submits the stimuli to strong competition.

Because perception "chunks" the information, it can handle large amounts of information simultaneously, through cues. Bob Snyder states that the "front edge" of conscious awareness holds three pieces of information at the most [18]. He describes how events activate memories that have been previously activated by similar events. Many of these memories remain unconscious, forming expectations. Snyder coins the term *semiactivated memories* to describe this unconscious information, which plays a crucial role in conscious awareness.

We derive the meaning of the parts from the meaning of the whole, according to gestaltist principles [19, 20, 21, 22] and multisensory integration processes [23, 24, 25, 26]. Every percept results from simplifying sensory information according to presuppositions, which are mostly unconscious.

At the same time, we can be consciously aware of the broad membrane of complexity formed of that same information. Perceptual simplification dominates when we focus on a purpose such as discerning a cause and a meaning, or accomplishing a task. Perception can prioritize sensory information in different ways when we are not driven by any purpose, focusing on the experience itself. The brain makes use of assumptions to simplify and clarify the perceptual field, and simultaneously it draws upon their ambivalence (Fig. 1).

As a performer, dealing with non-anticipated – yet determined - sonic events makes me acknowledge and respond to sensory details that I would otherwise not be consciously aware of. In a sense, creating musical meaning upon the unexpected augments my sense of control. As my capability of response is challenged, my sensitivity and resourcefulness become greater than if I was strictly executing a plan.

Performative action must exceed intellectual deliberation, since it possesses biophysical logics. That which makes a sonic event "right" or "wrong" is very subtle. A digital sound arising unexpectedly could feel "wrong" within the musical logics, yet that logics can shift such that the event becomes gloriously "right". The immediacy of the acoustic instrument enables me to incorporate the unexpected event while shifting the musical direction in good time - boldly or surreptitiously.

For almost twenty years I have created and performed with custom instruments combining analogue and digital components, not only to extend the music as connected with light, weather, architecture or movement, but also to explore the compositional potential of chaotic behaviors. Currently, the combination of acoustic and digital provides me with immediacy and mediation - the instrument thresholds control and unpredictability so as to potentiate expression.

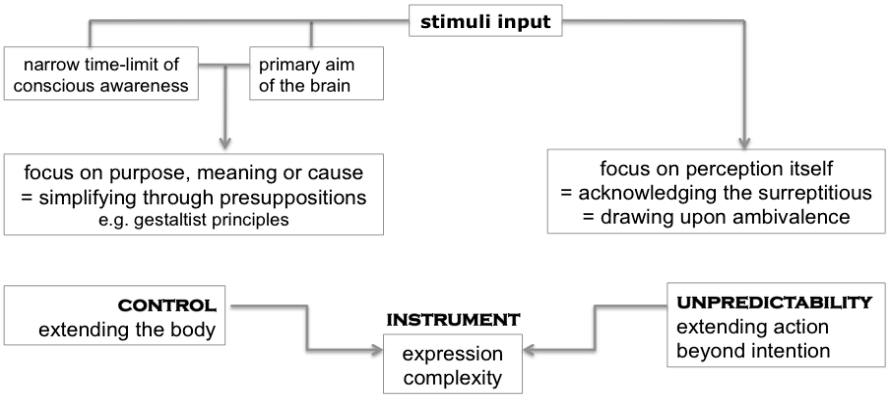

Fig. 1. The experience of complexity. (© Adriana Sa)

References and Notes

1. Thor Magnusson, "Of Epistemic Tools: Musical Instruments as Cognitive Extensions," *Organised Sound 14, no. 2* (2009), pp. 168-176.

2. Magnusson [1] p. 172.

3. C. Poepel and D. Overholt, "Recent developments in violin-related digital musical instruments: where are we and where are we going?," *Proceedings of the International Conference on New Interfaces for Musical Expression* (2006), pp. 390–395.

4. Andrew Johnston, "Beyond Evaluation: Linking Practice and Theory in New Musical Interface Design," *Proceedings of the International Conference on New Interfaces for Musical Expression* (2011), pp. 280–283, p. 293.

5. As an example, a set of compositional strategies is described in Adriana Sa, "How The Audio-Visual Can Favour The Sonic Experience", L. Aceti, S. Gibson, S. M. Arisona, O. Sahin, eds, in *Live Visuals for Performance, Gaming, Installation, and Electronic Environments / Leonardo Electronic Almanac 19, 3* (MIT Press, 2013).

6. C. Poepel and D. Overholt [3].

7. For further details see Sa [5].

8. John Cage, *Silence: Lectures and Writings 1939 – 1961* (Connecticut, USA: Wesleyan University Press, 1961).

9. Peter Vergo, *The Music of Painting: Music, Modernism and the Visual Arts from the Romantics to John Cage* (Phaidon, 2010).

10. Staina and Woody Vasulka, *Machine Media* (New York, USA: MoMA, 1996).

11. Kim Cascone, "The Esthetics of Failure: Post-Digital Tendencies in Computer Music," *Computer Music Journal 24 no. 4* (2000) pp. 12-18.

12. Cage [7] p. 158.

13. Karl R. Popper, *The Open Universe: An Argument for Indeterminism* (Totowa, Rowland and Littlefield, 1982) p.125.

14. H.L. Bergson, *Matter and Memory* (Matière et Mémoire, 1896) transl. N.M. Paul, W.S. Palmer, Allen, London, 1990.

15. *The Handbook of Multisensory Processes*, G. A. Calvert, C. Spence and B. E. Stein, eds. (MIT Press, 2004).

16. Bob Snyder, *Music and Memory: An Introdution (*Cambridge, USA: MIT Press, 2001).

17. Eric Knudsen, "Fundamental Components of Attention". In *Annual Review of Neuroscience 30, no.1* (2007), 57-78.

18. Snyder [15].

19. Max Wertheimer, "Laws of Organization in Perceptual Forms", in W. Ellis, ed., *A Source Book of Gestalt psychology (*London, UK: Routledge & Kegan Paul, 1938) pp. 71-88.

20. E. Rubin, *Visuell Wahrgenommene Figuren - Studien in Psychologischer Analyse* (Copenhagen, Denmark: Gyldendalske Boghandel, 1921).

21. K. Koffka, *Principles of Gestalt Psychology (*London,UK: Lund Humphries, 1935).

22. A. S. Bregman, *Auditory Scene Analysis – The Perceptual Organization of Sound* (Cambridge, USA: MIT Press, 1990).

23. H.L. Pick, D. H. Warren, D. H. and J.C. Hay, "Sensory Conflict in Judgements of Spatial Direction," *Perception Psychophysiology, no.4* (1969) pp. 203–205.

24. H. McGurk and J. MacDonald, "Hearing Lips and Seeing Voices," *Nature 264* (December 23, 1976) pp. 746–748.

25. L. Shams, Y. Kamitani, and S. Shimojo, "Visual illusion induced by sound," *Cognitive Brain Research 14* (2002) pp. 147-152

26. D. Talsma, D. Senkowski, S. Soto-Faraco and M. G. Woldorff, "The Multifaceted Interplay Between Attention and Multisensory Integration," *Trends in Cognitive Sciences 14, no. 9* (2010) pp. 400-410.