Serendipity in a Multidisciplinary Acoustic World

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Introduction

The goal of this essay is to compare the role of serendipity in various fields of acoustics and music from my personal experience (see **Figure 1**). For this essay, the relationships and what you can deduce from my examples are more important than the research findings themselves. I tried my best to give a summary of each finding, but some of the models are very technical. The references provide a complete description for readers interested in specific details. I organized the essay according to my research interests and topics.

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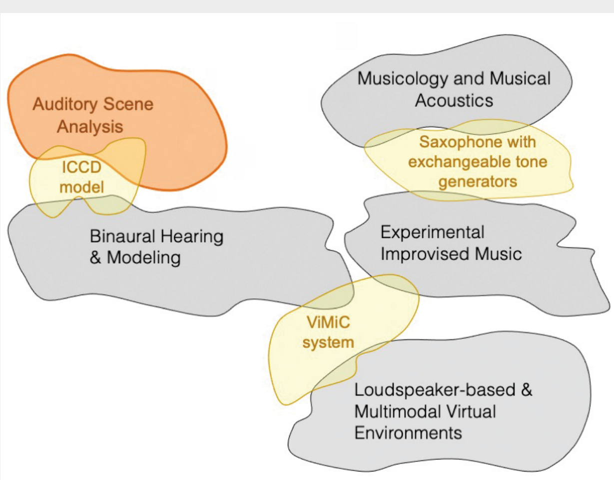
Physics

When I entered college in 1992, I was not sure what career I would like to pursue, so I studied physics in Dortmund, Germany, to be broad enough to figure out a career path later. About a year and a half into my studies, I spent a lot of time in the library studying for my oral pre diploma math exam. Near the end of the day, I often found myself wandering between columns of books. One day, a long shelf of books with light blue backs caught my eye. Serendipity struck me, and I picked up a book in the middle of the blue row, which turned out to be the proceedings of the German Acoustical Society. I realized that many of the articles came from a few laboratories, including Jens Blauert's nearby Institute of Communication Acoustics at Bochum University, Bochum, Germany. I started getting excited enough to check out the Bochum University course catalog and, then, took Jens' courses. Studying with Jens was great. He was a true pioneer in binaural technology, very supportive, and super precise with scientific language. Looking back, serendipity worked well for me by meeting future mentors by chance. I think the main reason for this is I had never predetermined goals but went with the flow of matters that excited me.

Figure 1. *Research areas with mentors I came across during my career (**gray areas**). **Yellow areas** highlight the three research examples where serendipity played a role. ViMiC, virtual microphone control [system]; ICCD, interaural cross-correlation difference (model). **Red area** depicts the field, Auditory Scene Analysis, I was not engaged with at the time of the research finding.*



Engineering, Communication Acoustics, and Musicology

In parallel to physics, I studied musicology at Bochum with Christian Ahrens and later wrote a doctoral dissertation

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on free reed stops in pipe organs (Braasch, 2004). I soon became interested in ethnomusicology and musical instrument studies, and I valued that these studies aligned well with my studies in saxophone performance. Christian was one of the most diligent humanities scholars I have met, and his profound expertise was complementary to Jens in many ways.

When I studied musicology, the *Institut de recherche et coordination acoustique/musique* (Institute for Research and Coordination in Acoustics/Music; IRCAM), Paris, France, was somewhat the holy grail for avant-garde music worldwide. I started to read IRCAM's research publications, and I really enjoyed Stephen McAdams and Emanuel Bigand's book *Thinking in Sound*, which resulted from an IRCAM workshop. The whole book really bridged perception and avant-garde music practice very nicely, something I was both interested in. In particular, I was fond of Al Bregman's (1993) chapter on "Auditory Scene Analysis" in this book. By the time I read Al's chapter, I had become a doctoral student of Jens (starting in 1998). Reading the chapter, it suddenly struck me that I could apply this seemingly unrelated topic to my PhD research on modeling auditory localization perception of two concurrent sound sources. I outline how, thanks to serendipity, I suddenly had the solution for all my problems for this research in front of my eyes.

My initial problem was that I could not predict the perceived lateral location of a target sound in the presence of a secondary sound, the distracter, when both overlapped spectrally. Human listeners have no problems performing this task, but when I examined the interaural cross-correlation patterns, the most common method to simulate auditory localization processes, I just saw a very undefined interference pattern that, on average, suggested a single sound source that was located in between the actual two sounds, the target and the masker.

Bregman's (1993) auditory scene analysis theory explores how listeners can extract information from complex multisource sound patterns. One essential concept I came across reading Bregman's book chapter is the old-plus-new strategy, which states that listeners often assume that the old sound is ongoing when a new sound arises. In nature, sound properties of unrelated sounds usually do not change abruptly at the same time. I realized that I ignored an essential part of my experiment, namely, that my distracter needed to precede the target so the listener could distinguish the target from the distracter and correctly identify the target location. With this insight, I could easily predict the perceived location of the target by subtracting the interaural cross-correlation function of the preceding distracter part from the average interaural cross-correlation function of the part when the target and distracter overlapped. I should note that in this experiment, the target was never presented to the human listeners in isolation. To provide further evidence that this model was an adequate predictor of human perception, I could show that listeners were not able to localize the target when the preceding distracter portion was removed. Once I connected my problem to Bregman's old-plus-new strategy, it took me less than a week to create a proof-of-concept model and then, of course, it took me about a year to work out all the details for a publication (Braasch, 2002).

There is an old joke that the difference between a generalist and a specialist is that the specialist knows everything about nothing and the generalist knows nothing about everything. I see myself as a multispecialist with a few areas of expertise that drift through space and time, like tectonic plates, and sometimes they align in a funny way. Then serendipity sometimes makes the connection, forming the bridge to a new concept.

Sound Recording

Engineering solutions are often found by transferring a solution from one field to another. The circumstance in which I developed the virtual microphone control (ViMiC) system was also a series of lucky coincidences. When Jens retired, a position in music technology at McGill University, Montreal, Quebec, Canada, caught my eye because it was related to my work on pipe organs. Wieslaw Woszczyk, the chair of McGill's Sound Recording Department, liked Jens' research and thought it would be worthwhile to interview one of his students.

At that point, I had some experience recording my own music but no formal training in this area. A friend recommended reading Dickreiter's (1997) seminal book that I read on my flight to my interview. One thing that was completely new for me was the concept of main stereo microphone techniques where the sound engineer strategically places two microphones such that the sound delay and intensity differences between both microphones translates to interchannel time and level differences. The latter allows listeners to localize sound sources left and right when the recorded stereo microphone signal is presented via two loudspeakers placed at a 60° angle in a typical stereo system. I realized that the related math was not that different from dealing with head-related transfer functions (HRTFs) in binaural technologies for headphone-based sound.

After getting the job at McGill, I started to implement main microphone techniques into a real-time virtual environment using the techniques we developed at Bochum for HRTFs and named the system ViMiC (see, e.,g., Braasch et al., 2008). We set up the ViMiC system in McGill's 24-channel audio system, and the system offered similar flexibilities to shape the width and character of an auditory image that recording engineers know from their sound recording practice, whereas other common spatialization techniques were more concerned with accurately reproducing just the directionality of the rendered sound.

Architectural Acoustics and Experimental Music

Pauline Oliveros (see bit.ly/4e25AMl) was another important mentor in my life. I met her in 2006 when I started an assistant professor position at Rensselaer Polytechnic Institute, Troy, New York, in architectural acoustics. Pauline was a world-class composer and improviser. She founded a well-known practice called *Deep Listening,* which is based on critical listening, breaking conventions, and intuition. Pauline was probably the most intuitive person I met in my life. She was a pioneer of modern artistic research, and her work is a good example of how serendipity can play a different role in the arts from that in science or engineering. Pauline was an advocate of not practicing music material because she claimed that one would only fall into repetitive patterns.

Having had prior experience in freely improvised music, I decided to help Pauline co-teach her graduate music ensemble class. The way Pauline thought and practiced artistic research was fundamentally different from anything I had experienced before. If science is dedicated to understanding the laws of the universe and learning how it operates, engineering finding technical solutions to known problems, and humanities to understanding historical trends in social interactions, artistic practice was something I had much more difficulty with grasping it formally. If I come back to the idea of comparing my research areas to "tectonic plates" that loosely drift aside from each other, a common artistic practice is to try to push one's plate as far into unknown territory as possible.

This can be done, for example, by installing a new framework with unknown consequences. A good example is the invention of quarter-tone music, where one divides the octave into 24 instead of 12 equal-tempered intervals and sees what the perceptual/artistic consequences are. Pauline's approach was the opposite, removing known frameworks and letting intuition navigate music in uncharted territory. Serendipity does not play a big factor in this because you are technically not finding something other than what you are looking for because you are not specifically looking for something.

However, you can still find a lot of new things accidentally. Pauline, Doug Van Nort (see dvntsea.com), and I had a free improvisation trio, *Triple Point*, from 2008 until her death at age 84 in 2016 (Triple Point, 2014; see also bit.ly/3UDmB7M). Her two regular complaints with me were that the saxophone was too loud (that's why Adolphe Sax invented it) and that I was overthinking everything (probably the physicist in me). One day, I got myself in trouble because I found no time to prepare myself for a saxophone solo concert at the Deep Listening *Dream Festival*. The only option I had left was to follow Pauline's advice to let go and not think about anything during the solo. After the concert, Pauline simply commented, "*You finally got it.*"

Later, serendipity played an important role in my artistic work. My two major concerns about my own saxophone performance in *Triple Point* were the lack of sound flexibility and the feeling that I had not developed my unique saxophone practice yet. I became aware of the static nature of the saxophone timbre when Pauline started to use a Roland synthesizer accordion interface that was able to produce any conceivable sound using physical modeling. It did not help that Doug as an electronic musician who works a lot with sampled sounds and granular synthesis, among other techniques, also had an endless repertoire of different sounds and timbres.

One day, I was preparing a section on nineteenth-century wind instrument practice for the aural architecture class

I was teaching when I came across the story that Adolphe Sax was also a brass instrument builder and often interchanged concepts between brass and woodwind instruments. In fact, the saxophone had much in common with the ophicleide, an early nineteenth-century brass instrument with keys. It suddenly occurred to me in a serendipitous moment that I could simply replace my saxophone mouthpiece with other tone generators as part of my experimental music practice to get a lot of different sounds. It took me many years, though, to learn to play all my tone generators, and I eventually wrote a book titled *Hyperspecialization in Saxophone* about it (Braasch, 2019; listen at vimeo.com/898780205).

Independent of the academic field, we try to maximize our creative output. Serendipity can be very effective in this context. In my experience, research stemming from serendipity often falls into the risky research category. I remember that after practicing my different tone generators for about five years, I sat there in disbelief and asked myself why I was so persistent without even knowing if this would ever lead to something useful one day or not.

On the opposite side of serendipity, I sometimes found myself willfully ignoring important things around me in my career to stay focused. For this reason, I did not really dive deep into Pauline's Deep Listening philosophy. In 2015, she insisted that I participate in her Deep Listening certificate program. I was pretty reluctant in the beginning, especially because regular Sunday meetings are not the most family friendly activity to commit to, but in the end, I was very grateful to learn all her fantastic philosophical Deep Listening concepts in the last class she fully taught herself.

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