Serendipity Is the Company You Keep

John R. Buck

*John R. Buck [**center**] with Andy Singer [**left**] and Kathleen Wage [**right**] in July 2024.*

Introduction

There is a hockey cliché that the best saves are when the goalie puts themself in position and just lets the puck find them rather than reacting to the shot. I believe the same applies to serendipity. Serendipity is more likely to strike when you put yourself in a good place and wait rather than if you actively pursue it. The serendipity I have known has been more in the colleagues who found me than blinding insights. My colleagues have expanded my scientific horizons while challenging me to be my best self. None of these collaborations grew out of deliberate planning but emerged from happy coincidences and thwarted plans that is serendipity. In this essay, I describe the origins of some of my rewarding collaborations and then distill from these experiences four suggestions to improve your chances to find serendipity or have it find you. Finally, I apologize in advance to the many wonderful colleagues that space limitations preclude me from including in this essay.

A career spent studying signal processing offers broad opportunities for collaboration. Every discipline in science and engineering extracts information from signals. Some signal processors choose to stay close to home, focusing on traditional applications such as audio, speech, and wireless communications. Much of my most enjoyable (and according to citation indices, impactful) research has been in animal bioacoustics. This was not the plan. As an undergraduate electrical engineering student, I focused my coursework on signal processing and further specialized in speech processing during summer internships in digital telephony. During my first year of graduate school at MIT, Cambridge, Massachusetts, my advisor, Alan Oppenheim, suggested that I could spend my summers at the Woods Hole Oceanographic Institution (WHOI), Woods Hole, Massachusetts, if I applied the speech enhancement algorithms I had been studying to underwater sounds. That was all the encouragement I needed to pivot from speech to underwater acoustics.

As I finished my MS degree in the spring of 1991, I planned to take a break from graduate school to teach high school for a few years. I was looking for a summer position to fill the gap before a teaching job would start, and the WHOI Marine Animal Bioacoustics Laboratory, led by Bill Watkins (WHOI, 2004), was looking to hire a signal-processing student just for the summer. That summer in Shiverick House, as the laboratory was metonymically known within WHOI, Peter Tyack (2024) and I developed an algorithm for classifying bottlenose dolphin whistles from their fundamental frequency contours.

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Caldwell and Caldwell (1965) proposed that the fundamental frequency contour of a bottlenose dolphin's whistle contained individually identifying information, making these contours a natural feature for classification. Speech-recognition researchers had previously explored contour comparisons but found that these features were not reliable for classifying human speech or speakers. As chance would have it, I learned about these contour comparison algorithms during my previous summer internships. The serendipity of recognizing that a discarded speech-recognition technique was exactly the right tool for classifying dolphin signature whistles resulted in my first published paper in *The Journal of the Acoustical Society of America* (*JASA*) (Buck and Tyack, 1993).

More importantly, that summer began a friendship and collaboration with Peter Tyack that has spanned two continents, three decades, and four marine mammal species to date. Meanwhile, other scientists following our work applied the contour comparison algorithm to signals from birds, killer whales, fin whales, and blue whales among other species. In the end, I did not get hired to teach high school and continued into the PhD program. But for my thwarted plans to teach high school, I may never have met Peter nor started collaborating in animal bioacoustics.

The Shiverick House lunch table was an informal seminar on the practice and history of marine mammal bioacoustics. During one of those lunches, Tyack described the hierarchical organization of humpback whale songs proposed by Payne and McVay (1971). As he sketched trees and transition diagrams for themes on a piece of scrap paper, I felt something click in my mind connecting these figures to the Hamming codes and Markov models I had studied in my electrical engineering classes. These ideas lay fallow for several years while I completed a more traditional PhD dissertation in ocean acoustic signal processing.

When I started my faculty position at UMass Dartmouth, I eagerly returned to investigating humpback whale songs with mathematical methods from information theory as part of my first National Science Foundation (NSF) grant. Serendipity played a critical role here as well. Just as the NSF grant started, a talented undergraduate student named Ryuji Suzuki contacted me inquiring about a possible research internship. In addition to his strong math skills, Ryuji's amateur radio background gave him extensive practical experience with communication theory and vintage audio electronics. Ryuji soon identified Wyner et al.'s (1998) nonparametric entropy estimator as the tool we needed to analyze the structure of humpback songs.

Adding another layer of improbability, the reel-to-reel tape recordings Tyack had made for his PhD field work were housed at Ocean Alliance, just over an hour's drive from our campus. These recordings contained long uninterrupted songs from a single whale, exactly what we required for entropy estimation. Ryuji's audio expertise allowed him to coax the reel-to-reel tape machine to play the original recordings so we could digitize them, providing hours of humpback song data. The string of serendipitous events that led Ryuji from Japan to a small public university campus in Massachusetts at just the right time with the perfect background to collaborate with me and Peter on the humpback song project would be completely implausible in a novel, but the result was one of the most intellectually exciting interdisciplinary projects of my career (Suzuki et al., 2006).

At the May 2000 Acoustical Society of America (ASA) meeting in Atlanta, Georgia, Doug Cato from the Australian Defence Science and Technology Organisation presented a talk describing the dramatic change in the eastern Australian humpback population song recorded by his PhD student Michael Noad from 1995 to 1998. Serendipity intervened here as well, scheduling Doug and me to speak in the same session and nearly consecutively. Doug and I met for lunch the next day, and we quickly recognized that analyzing their Australian humpback song recordings with our information theory techniques was too promising an opportunity to pass up.

Three years and a successful Fulbright proposal later, I joined Doug, Mike Noad, and others at the Office of Naval Research (ONR)-funded Humpback Acoustic Research Collaborative (HARC) experiments in Queensland, Australia. This month-long field experiment yielded a remarkable dataset of humpback songs as well as a lifetime of memories. Although I am proud of the paper we published (Miksis-Olds et al., 2008), the collaborations with Doug, Mike, and Tracey Rogers were the lasting gifts from my Sydney sabbatical. A few years later, as we enjoyed one of many delightful meals together, Doug first focused my attention on another form of serendipity we too often take for granted. How wonderful is it that a career in science brings together friends born half a world and decades apart?

Reading these reflections may have you wondering: how can you put yourself in a place where serendipity can find you? I have distilled four suggestions for students and young scientists from my own experiences.

First and most important, make space for serendipity. For me, this space is usually physical exercise (a run, a bike ride, or a walk). The time alone (no earbuds!) allows my mind to wander productively. Better still, sharing the exercise and conversation with a friend often spurs both of our thoughts in new directions. Without a notebook or computer at hand, you think conceptually about how the parts of your problem fit together. You stop worrying about the trees and focus on the forest. For example, the breakthrough on the universal dominant mode rejection beamformer (Buck and Singer, 2018) emerged during a long bike ride outside Champaign, Illinois, with Andy Singer of the University of Illinois.

The space for serendipity can also be time. During his years at Bell Laboratories, the mathematician Richard Hamming devoted 10% of each week to reading and thinking about ideas not directly related to his current project (Hamming, 1986). Tech companies such as 3M and Google allow employees to pursue passion projects to boost innovation (Johnson, 2010). Hobbies such as music and art can focus your attention, creating space for new ideas to percolate into your conscious mind.

Second, create space for serendipity in your conversations by learning to listen more patiently. American academic culture trains us to race to answers like a contestant on a TV game show. These habits can hamper interdisciplinary research because we rush to solutions that do not really fit the problem. Bringing interdisciplinary collaborators up to speed provides a great opportunity to step back and reexamine previous assumptions and approaches. Slow down. Ask your colleagues to explain the question they are trying to answer, not the problem they are trying to solve. As you listen, be alert for jargon hiding in everyday language. Be suspicious of words that everyone uses without defining. Words like *active sensing*, *information,* or *coherence* have all sown confusion in projects during my career. Ask potential collaborators to unpack unfamiliar terms for you. Often, you will both learn something when they do.

Third, learn the fundamentals of your discipline as deeply as possible. Making space *for* serendipity won't yield fruit unless you invest the hard work to prepare the intellectual soil for the seeds that fall. Go beyond the formal mathematical incantations. Drill down to recognize the underlying conceptual frameworks behind the notation. This deeper understanding will help you to recognize a problem that you have solved before when it reappears wearing a new set of variables.

Indeed, teaching foundational undergraduate classes is a great opportunity to strengthen your conceptual understanding of your own discipline. I was fortunate that my PhD advisor, Alan Oppenheim, supported and encouraged my passion for teaching. Finding accurate analogies to help the students link the mathematical ideas to everyday experience stretches my creative reach and helps the students grasp the ideas and concepts. Many potential collaborators will have less background in your discipline than the undergraduates you are teaching. Developing your ability to explain the concepts accurately in everyday language opens more doors for serendipitous collaborations.

Fourth, balance your deep understanding of your own field with a broad general understanding of adjacent disciplines. Kauffman (2000) coined "the adjacent possible" to describe the set of things just one step beyond the currently available domain, whether these things be mathematical ideas or chemical compounds. In *Where Good Ideas Come From* (2010), Johnson expands on Kauffman's idea: "The strange and beautiful truth about the adjacent possible is its boundaries grow as you explore those boundaries." Building breadth allows you to expand the boundaries of your adjacent possible. Read journal papers and attend talks in related disciplines. At your next ASA meeting, make time to attend a session sponsored by a different technical committee.

When expanding the breadth of your knowledge, do not try to memorize detailed derivations or complicated notation; challenge yourself to recognize the larger intellectual landscapes. What questions are researchers in that field trying to answer? How do they think about these problems? Where are their approaches similar to those you already know, and where and why are they different? Fowler's (2001) excellent essay on the difference between reading a journal paper and a textbook is a great starting point for this practice of strategic reading. This skill requires mental discipline and practice but will pay dividends if you persist and improve. Scientific serendipity often resides in these interstitial regions between established domains.

Initially, it felt like a serendipitous chance that among hundreds of graduate students in the MIT Electrical Engineering and Computer Science Department, Andy Singer, Kathleen Wage, and I served as teaching assistants in the same classes. In hindsight, I see that this serendipity grew from shared pedagogical instincts. We were excited about project-based learning and conceptual assessment before these approaches were widespread in engineering pedagogy. We also delighted in making the classes fun for the students. Discussing potential exam problems while walking across campus to get lunch grew into runs, walks, and bike rides debating array processing. Brainstorming better MATLAB projects flowed into discussions of underwater acoustic propagation. These graduate school peers blossomed into lifelong friends who bring out the best in me time and time again.

The ground rules for these essays prohibit coauthors, but Kathleen and Andy deserve some credit for the four recommendations I listed above. This advice grew out of our shared lived experience: digging for deeper understanding of signal processing, sharing new ideas we found in neighboring fields, listening thoughtfully to each other, and ruminating on what we had heard. Serendipity combines curiosity, surprise, and delight as we find unexpected new meanings in the world. Andy, Doug, Kathleen, Mike, Peter, Ryuji, and many others have engaged my curiosity and delighted me with surprising new insights. The joy I have found in these friendships is the great gift of my career.

References

Buck, J. R., and Singer, A. C. (2018). A performance-weighted blended dominant mode rejection beamformer. *2018 IEEE 10th Sensor Array and Multichannel Signal Processing Workshop (SAM)*, Sheffield, UK, July 8-11, 2018, pp. 124-128.

Buck, J. R., and Tyack, P. L. (1993). A quantitative measure of similarity for *Tursiops truncatus* signature whistles. *The Journal of the Acoustical Society of America* 94(5), 2497-2506.

Caldwell, M., and Caldwell, D. (1965). Individualized whistle contours in bottle-nosed dolphins (*Tursiops truncatus*). *Nature* 207, 434-435.

Fowler, M. (2001). *How to Read Signal Processing Journal and Conference Papers*. Available at https://bit.ly/3WwOgY3. Accessed July 15, 2024.

Hamming, R. (1986). *You and Your Research*. Transcribed by J. F. Kaiser, Available at https://bit.ly/3AcpaGA. Accessed July 15, 2024.

Johnson, S. (2010). *Where Good Ideas Come From: The Natural History of Innovation.* Penguin, Riverhead, New York, NY.

Kauffman, S. (2000). *Investigations.* Oxford University Press, Oxford, UK.

Miksis-Olds, J. L., Buck, J. R., Noad, M. J., Cato, D. H, and Stokes, M. D. (2008). Information theory analysis of Australian humpback whale song. *The Journal of the Acoustical Society of America* 124(4), 2385-2393.

Payne, R. S., and McVay, S. (1971). Songs of humpback whales. *Science* 173, 585-597.

Suzuki, R., Buck, J. R., and Tyack, P. L. (2006). Information entropy of humpback whale songs. *The Journal of the Acoustical Society of America* 119(3), 1849-1866.

Tyack, P. L. (2024) *University of Saint Andrews Research Profile*. Available at https://bit.ly/3SMYanp. Accessed August 11, 2024.

WHOI (Woods Hole Oceanographic Institution). (2004), *Obituary for William A. Watkins*. Available at bit.ly/3WYkMnk. Accessed August 11, 2024.

Wyner, A. D., Ziv, J., and Wyner, A. J. (1998). On the role of pattern matching in information theory. *IEEE Transactions on Information Theory* 44(6), 2045-2056.

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