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Human Kinetics
EDITORIAL

Lessons Learned

In this issue, JAB continues a series of editorials from highly impactful faculty and researchers on "lessons learned" throughout their careers or lives. The hope is that the rest of us can benefit from their experiences. I would like to thank these individuals for sharing their thoughts with us.

—Michael Madigan, Editor-in-Chief

I really appreciate the *Journal of Applied Biomechanics* inviting me to present my thoughts on lessons I have learned during my career in biomechanics. It provided a great opportunity to reflect on my career and the mentors and colleagues who shaped it. Here are some of the lessons that are the most important to me.

Let your career take you where it takes you: Your academic journey will have many twists and turns, and you cannot control all of them (and that is a good thing). When I was in high school, Dr Wayne Marino came in from the University of Windsor and performed some analyses on my lacrosse team. I knew immediately that I wanted to be a Sports Biomechanist. Wayne mentored me through my undergrad, but, when it came time to apply to graduate programs in the mid-1980s, he advised me that funding was limited for sports science in North America and, unless I wanted to study in the Eastern Bloc, I should go to the University of Waterloo and learn occupational biomechanics. I did and soon realized that biomechanics is biomechanics and that studying people in the workplace presented exciting challenges and profound rewards. I was blessed to be mentored by Dr Bob Norman and Dr Stuart McGill, arriving months after they had published their landmark lumbar spine model. Talk about being in the right place at the right time!

I dedicated myself entirely to spine biomechanics for 10 years until meeting Allison Stephens from Ford Motor Company. She wanted to fund ergonomics research in my lab, but all her questions were related to the upper extremities, and I soon realized that they necessitated psychophysical methods to answer them properly. Both were new areas for me, but challenge accepted. At the same time, a colleague had moved to a major sports equipment and apparel manufacturer and initiated discussions for me to run their basketball division. Fifteen years earlier, that would have been my dream job, but I do not think anyone would have taken the career path I did to get it. Ultimately, that did not work out, but I did move back home to the University of Windsor, just across the river from Detroit. That began almost 20 years of ergonomics research in partnership with Ford and launched many rewarding careers for my students entering through the gateway of automotive manufacturing. Talk about being in the right place at the right time a second time!

I eventually moved again, this time to McMaster University, so that I could supervise doctoral students. That led to a focus on knee stability that is now culminating in research with Chad Sutherland related to the potential effects of muscle fatigue on injury risk for athletes during landing and cutting. So, it has all come full circle, but I could have never planned the path. I learned that you need to recognize great opportunities when they present themselves (even if they are on a tangent to what you think you do), make the best of those opportunities, and accept a new direction to your research if that is what feels right to you.

But, be sure to connect the dots: I recently read a commencement speech quote from Steve Jobs: "You can't connect the dots looking forward; you can only connect them looking backwards. So, you have to trust that the dots will somehow connect in your future." That really resonated with me. As you might have gathered from the previous section, I moved around a bit in my career. I had to write a research statement when I applied for my three faculty positions. Each time, I was surprised at how all my research projects followed various threads. On reflection, I could connect the dots between most of what I had done, and it was a great exercise for establishing the course I would set going forward (though I ultimately deviated from that course every time). I am currently embarking on a major software development project and am surprised that I can incorporate just about everything I have ever done in my research and consulting career. I love it when a (lack of) plan comes together! I learned that this dot-connecting exercise should not be limited to trying to impress a hiring committee. This should be something we do at least once a year.

Become an integrated biologist: One of the most difficult challenges in my research is estimating individual muscle forces, most often under fatiguing conditions, because there is no reliable method to do this directly. That was true at the start of my career, and unfortunately, it is still true almost 35 years later. So, many of us in biomechanics use surface electromyography to estimate muscle force. This comes with many challenges and, frankly, heartbreak. However, it forced me to understand muscle physiology and neural control in a way that I likely would not have, if I had direct force measurements at my disposal. However, it has also ultimately made me a better biomechanist. I sometimes chide my motor control and exercise physiology friends that none of what they study would matter if the muscles weren't there to transmit force, but over my career, I have learned that the same is true in the opposite direction, and it takes an integrated biologist to read the whole story.

"Use-inspired" research is very rewarding (and fundable): As my research started to become more "applied," I worried about the perception that my focus was becoming less "basic." Then I read the book "Pasteur's Quadrant" by Donald E. Stokes, and it perfectly encapsulated my research philosophy. Stokes argues that we should not simply view research on a continuum from "basic" to "applied." Instead, we should see each of those on their own orthogonal axes. Those that are on both a quest for fundamental understanding but also consider the practical applications of their findings are in what he called "Pasteur's Quadrant." Was Pasteur a basic or applied researcher? Well, he is the Father of Microbiology (drop the mic) but he also created the first vaccines for rabies and anthrax, invented pasteurization (obviously), improved methods of fermentation, and developed antiseptic methods for surgery (to name a few). He had both a drive toward understanding and toward control and facilitated this with "use-inspired" research. With this paradigm formally defined by Stokes, I learned to embrace the more applied aspects of my research while still

maintaining a commitment to better fundamental understanding of the effect of work on human tissues. This has also greatly affected my approach to teaching and created many more research funding and employment opportunities for my students.

Challenge accepted dogma: I was not much of a rebel when I was younger, but as a researcher, I developed a propensity to question what had already been accepted as fact. This resulted in research findings that, while not always popular or even acknowledged by some, challenge long held "standards" for, among other things, surface electromyography processing methods, ergonomics assessments, and resistance training for strength gains. It also forced me to be much more critical of my own scientific beliefs, as I do not want to open the door for some other skeptic to prove me wrong in the future.

Do not seek out failure—But embrace it after it inevitably occurs: Failure is never easy. It is particularly discouraging to spend substantial time, effort, and resources on a project and not find what you hypothesized you would. It is even more uncomfortable when the research was conducted by your graduate student who trusted the "brilliance" of your theories. However, my most rewarding discoveries have come when I could not have predicted the results. Ultimately, proving theories tends to springboard from what we already knew and moves the field forward incrementally. Having to make sense of an unexpected result can uncover new knowledge and push the field forward in leaps and bounds. In fact, many of the most important research discoveries have been happy accidents. So, do not ignore or despair over unexpected results. Roll up your sleeves and seek to understand what they mean.

Fully appreciate your students and support staff: As an academic (if you are paying attention), you learn that these are the folks who do most of the work you get credit for. When supervising graduate students, find a style that works for you. There is no one best way. I tended to take a "friendtoring" approach, and it resulted in many wonderful relationships over the years. In fact, these friendships are, by far, the most rewarding aspect of my career, and they do not even appear on my curriculum vitae!

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