Kristen M. Donnell, Guest author

The Importance of the Fundamentals

Dear Readers,

This time, our guest author for the column on Future Trends in I&M is Kristen M. Donnell. Kristen is indeed a brilliant woman, who works hard with delight and passion. This is also confirmed by all of the awards she has received: Missouri University of Science and Technology 2014 Faculty Teaching Award; IEEE Instrumentation and Measurement Society 2012 Outstanding Young Engineer Award; Teaching Commendation for 2012-2013 Academic Year; Outstanding Teaching Award for 2011-2012 Academic Year; the ASNT Fellowship Award for the 2002-2003 and 2006-2007 academic years; the Missouri S&T Chancellors Fellowship for 2006-2009; and the Missouri S&T University Transportation Center Graduate Fellowship for 2006. She also received the Materials Evaluation Best Paper Award in 2005 and placed first in the student poster contest at Third International Conference on Electromagnetic Near-Field Characterization and Imaging in 2007.

I'm sure you will like her nice contribution.

Best wishes,

Simona

When Simona asked me to contribute an article to her regular *I&M Magazine* column, I was immediately honored that she believed I had something worthy to contribute and then immediately nervous – "What will I say?" As I thought about it, wondering what my own future trends are and will be as I proceed in my own academic career, the same concept kept coming back to me: fundamentals, fundamentals, and fundamentals. When I am not teaching as an Assistant Professor at Missouri University of Science and Technology, much of my time is spent writing proposals, oftentimes submitting to agencies that emphasize fundamental science. The other side of the academic paradigm focuses on applied science and engineering (which will never happen without a solid scientific and fundamental basis). So, as you can imagine, the fundamentals provide an important and critical footing upon which everything I do is built. Even at home, as I watch my almost 7 month-old daughter learn how to eat from a spoon, I again am shown an example of how important and necessary the fundamentals are to growth and progress.

A relevant question at this point might be, "OK, so what does '*the fundamentals*' mean?" The fundamentals are, in essence, the building blocks upon which all of our work is built, be it applied engineering, groundbreaking research, complex measurements, or even advanced coursework. To me, without a solid understanding of the fundamentals, it is nearly impossible to make substantial progress, making any future trend difficult to become a reality. I recently discussed a perfect example of this in my undergraduate electromagnetics course when we were discussing a fundamental electromagnetics law: Coulomb's Law of Electrostatic Force. Coulomb first published this law in the late 1700s, far before the existence of iPhones, computers, calculators, and advanced measurement equipment. When introducing this law to my students, I emphasize this lack of technology, and then ask the students to consider what tools Coulomb did have available. The answer is oftentimes, "None." This is where I suggest that perhaps a solid understanding of the fundamentals was the most important and critical tool available to Coulomb that may very well have been the critical piece to his work. As this class is the course where students learn the fundamentals of electromagnetic theory, which in turn opens the door to many practical and fun areas of electrical engineering including antenna design, high frequency circuit board design, microwave and millimeter wave engineering, and so on, the parallels to Coulomb's work are strong. Without these fundamentals, students simply cannot contribute to these important areas and will miss out on many fun and interesting applications of electrical engineering.

Let us turn our attention back to the lab – How do fundamentals affect us as we make measurements? Understanding the effect of the fundamentals in the laboratory allows us to design proper measurement setups and assists us in troubleshooting if things do not work the first time. Also, recall why we are in the laboratory in the first place. We are working on up-and-coming research, new designs, and new applications, all of which are setting future trends. But without the fundamentals, these future trends in engineering and instrumentation and measurement may not come to fruition.

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I will end this contribution with a short story that emphasizes the importance of knowing where to start and understanding the fundamentals of whatever it is you are doing, whether it is in the laboratory, on the computer, or in the classroom. While I was working on my PhD, I spent many hours in the lab making measurements to show proof of concept for a new sensor I was developing. Of course, the concepts used in this design were beyond "the fundamentals," but that does not mean the fundamentals do not have a place here. After spending several hours setting up a rather complicated text fixture and making time-consuming measurements, I opened my data files to make sure things looked as they should. Imagine my surprise when my new probe apparently did not detect a thing! As I wondered where in my design I had gone wrong, I happened to notice that my power supply, even though the switch was in the "on" position, was off. It turned out that the power supply was not plugged in. Had I taken a moment in the beginning to ensure that the proper amount of current was being delivered to my PIN diodes, I would have noticed this immediately. However, my neglect of the fundamentals cost me useful measurement data. So, in conclusion, having a solid understanding of the fundamentals allows us to move forward in our work, blazing the trail for future trends, and also gives us an excellent way to check our work along the way. Measure on, friends…and, don't forget to check the power cord!

Kristen M. Donnell (S'07-M'11-SM'12) received her B.S.E.E. degree in May 2001 from Colorado State University, her M.S.E.E degree in December 2003 from the University of Missouri-Rolla, and her Ph.D. degree in Electrical Engineering at Missouri University of Science and Technology (Missouri S&T) in December 2010. Her Ph.D. research was conducted at the Applied Microwave Nondestructive Testing Laboratory (*amntl*). She is currently an Assistant Professor in the Department of Electrical and Computer Engineering at Missouri S&T and a member of the research team at the *amntl*. Her current research interests include modulated antennas/scatterers, materials characterization, microwave and millimeter wave imaging, and hybrid nondestructive testing methods. Prior to starting her Ph.D. work, Kristen was employed by Raytheon Company, Tewksbury, MA from 2003 to 2006 as a Systems Engineer and Electrical Engineer. Dr. Donnell is a Senior Member of IEEE and is also involved with the IEEE Instrumentation and Measurement Society, where she served as an appointed member of the AdCom from 2007-2011 and is currently serving her first term as an at-large AdCom member.