

George Box: Scholar, Scientist, and Statistician

George Box, one of the true giants in the fields of statistics and quality engineering, passed away on Thursday, March 28, peacefully at home. George had a major influence on *Quality Engineering*. His primary influence was through the “Quality Quandaries” column that he instituted. He also occasionally published in the journal; his last article appeared in 2012 (Box and Woodall 2012).

As the past *Quality Engineering* editor who knew him best, I get the honor and privilege of writing this tribute. I know that over the next several months, many such tributes will appear in journals and at conferences. My goal is to give a personal view of George’s impact on the field of quality engineering and to this journal. For those who would like to learn more about George, please refer to the two following interviews with him (DeGroot 1987; Pena 2001).

George’s introduction to statistics was during World War II. He served as a chemist in the British army, testing chemical toxins on small animals. I first heard this story from George himself at the 1997 Southern Regional Council on Statistics (SRCOS) meeting in Gatlinburg, Tennessee. George gave a wonderful talk reflecting back on response surface methodology (RSM), which is a sequential experimental design structure very important to quality engineering.

George regaled us with the story of Sargent Box learning about experimental design on his own in order to do his experiments more efficiently. As always, George was both entertaining and enlightening. After the war, George worked for Imperial Chemical (now ICI). It was during this period of time that George began to develop experimental design strategies to optimize chemical processes. In this same talk, George relayed the story of how George Barnard, a famous British statistician who served as Imperial Chemical’s statistical consultant, discovered George’s work on the central composite design. George told the story of showing Barnard the basic structure of the design using chicken wire and tennis balls. Barnard’s reaction was pure astonishment, and he was instrumental in getting George to publish the seminal paper (Box and Wilson 1951) on RSM. The authors were listed as Mr. Box and Dr. Wilson. George did not have his Ph.D. at that time; however, he was the one who developed the statistical methodology. Dr. Wilson was a chemist who provided the basic context for the application of the methodology.

Immediately after the session, I introduced myself to George as Editor-Elect for the *Journal of Quality Technology* and invited him to submit his talk for publication in the journal. He graciously accepted on one

condition: he needed to publish a preliminary paper to set the stage for the context of the talk that he just presented. I immediately accepted his proposal, which then led to Box and Liu (1999) and Box (1999).

Box (1999) is an absolute classic. George outlines his vision of statistics as a catalyst for learning. He expounds upon RSM as an example of a sequential learning strategy, where we conduct a series of experiments, each building upon what was learned from the previous. All serious quality engineers/industrial statisticians need to read this article.

My favorite George quote (Box 1982) is “All models are wrong; some are useful” (11). Like all of his good quotes, it often is difficult to find a formal citation. This particular paper is a little difficult to find, but it is worth the effort.

Box (1982) wrote this paper during the height of the “discussion” that he and Jack Kiefer conducted in the literature. Jack was the father of D-optimal experimental designs. To say that George disliked optimal design theory would be an understatement. Box (1982) outlined George’s basic criteria for a good design. Underlying much of his discussion was the basic point that no statistical model is ever correct. He pointed out that such models suffer from underspecification (omitting certain important terms) and from overspecification (including certain terms that are truly unimportant). In fact, Box noted that both problems can happen simultaneously! Kiefer’s approach, on the other hand, assumed that the experimenter did know the correct model form, and his resulting claim of optimality depended heavily on this assumption. Box basically found such a claim ludicrous, which makes for some very interesting reading of the exchanges during this period.

Industrial statisticians and quality engineers must appreciate Box’s basic perspective on statistical models. Our goal should be “good” experimental designs that do well in terms of a broad array of criteria, some of which must seriously consider potential model misspecification. This notion of balance goes to the heart of Box’s philosophy of experimentation.

My second favorite quote attributed to George (supposedly said at one of the first Mohonk Conferences) is “Why do we aspire to be second rate mathematicians when we can be first rate scientists?” This remark does have some ties to the Kiefer debate, but it actually goes much deeper into the applications of statistics to real problems. Box is basically saying that

if we aspire to be effective in our collaborations with scientists and engineers, then we need to act like scientists and engineers. We need to be fully involved in the investigation and not on the sidelines waiting to be called into the game. It is crucial to note that Box, with his foundations in chemistry, never really stopped being a scientist.

With my primary research area in RSM, I am proud to say that George’s work has served as a true inspiration for what I do. Each day, I consider George more and more as an important mentor, even though I never took a class from him. The older I get, the more I glean from George’s insights, especially the need to become first-rate scientists, and I hope that I can transfer those insights to my students to inspire them in the same that he has inspired me.

George not only was the father of RSM but he also played a pivotal role in the development of time series analysis. I was told that he learned about time series early in his career at Wisconsin by working with a chemical reactor. He was interested in how to build effective empirical feedback and feedforward control systems, which is why the transfer function and noise model played such a prominent role in Box and Jenkins (1976). He had a real chemical problem to address, and he needed to develop appropriate methodologies to address it. Interestingly, George’s last technical book illustrated how to apply time series concepts and methodologies for process monitoring and control (Box et al. 2009).

George also was a truly delightful person. I always enjoyed my conversations with him; however, one event in particular stands out that exemplifies the type of person that he was. George had been named an Honorary Member, but health issues prevented him from personally receiving the honor that year. The following year Stu Hunter was also named as an Honorary Member, and Stu was George’s first Ph.D. student. The American Society for Quality (ASQ) honored both George and Stu at the same meeting (along with Genichi Taguchi) in Philadelphia. I took George and Stu out to dinner to celebrate. I also invited a recent master’s graduate to join us, and she sat between George and Stu for the entire dinner. There was very little talk of technical statistical issues. Instead, it was an evening of stories fueled by more than a little wine. The master’s graduate had a huge smile on her face the entire evening. She had seen the true person behind the publications and had

seen that he was a warm, generous, and humorous man. She got to meet the real George.

George had very strong ties to our journal, *Quality Engineering*. He created the column “Quality Quandaries” and wrote it for many years. Ultimately, he began to coauthor the column with Soren Bisgaard, who later took it over completely as George began to cut back on his activities. Ronald Does has continued the column since the passing of Soren a few years ago. *Quality Engineering* honored George’s 90th birthday with a special issue. George asked if he could contribute a paper. As the editor at the time, I immediately said of course! The resulting paper (Box and Narasimhan 2010) won the ASQ Brumbaugh award for the paper published in an ASQ journal that had the greatest impact on the application of quality control. It was George’s fifth!

I am very honored and humbled to say that I knew George. He led a long and wonderful life. I hope that we all celebrate his life and contributions.

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