Interview with Dick Scheaffer

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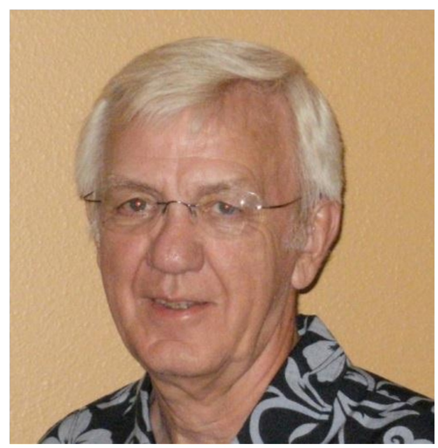

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Beginnings

AR: Hi, Dick. Thanks very much for agreeing to be interviewed for JSE. *I'll start by asking how you came to study statistics.*

DS: The opportunity to study statistics came out of my interest in mathematics, as is often the case in our field. I always enjoyed mathematics in high school, due in large measure to some very good teachers, so that was always a possible major when I entered Lycoming College, a small liberal arts college in my home town of Williamsport, PA. (Of course being colorblind made some other possible majors in the sciences rather foreboding; my "litmus test" was that I could not tell the color of the litmus paper.) With some success in my early courses I did decide to major in mathematics, with a career goal of high school teaching (influenced perhaps by those good teachers).

During my senior year, my advisor (and head of the mathematics department) called me into her office and told me I should continue my studies and get a Master's degree in mathematics.

Furthermore, she had arranged an assistantship for me at Bucknell University, where she had friends in the mathematics department. Being a naïve kid from the backwoods of the central Pennsylvania mountains who knew nothing about graduate schools or why anyone needed them, I simply said, “Yes, ma’am.” So, the next fall I put my high school teaching career on hold and toddled off to Bucknell, the 25-mile journey seeming long to me at the time.

I had never seen any statistics in my undergraduate math courses, and my only knowledge of the subject was a bit about the normal curve mentioned in a psychology course. At Bucknell, however, I found the most exciting teachers and most interesting courses to be in statistics rather than pure mathematics. Both the teachers and the topics in statistics seemed livelier and better connected to real world applications. So, I took all the statistics courses available, and began my teaching career as an instructor in introductory statistics during my second year of graduate work. That was nearly 50 years ago!

The two statistics professors at Bucknell when I entered were William Mendenhall and Paul Benson. Many have heard of the former through his textbooks, but few have heard of the latter. It was Professor Benson, though, who taught most of the statistics courses I took and who ingrained in me (and in many others) a true appreciation for the subject. He also insisted that we had to get doctorates if we wanted to have successful careers as statisticians in academia or elsewhere. I simply said, “Yes, sir.” So, the next summer we (I was married by then) toddled off to Florida (the thousand mile journey WAS long in those days). I took a few more graduate courses at the University of Florida under the tutelage of Bill Mendenhall, who was starting a statistics department there. I then moved to Florida State, which had an established statistics program, for my Ph.D.

In short, my story is similar to that of many others. I was influenced by good teachers who not only loved what they were teaching but also took a personal interest in students above and beyond the call of duty. That’s still a good message for all of us who teach.

AR: I grew up in Pennsylvania myself and lived there for 39 years, longer than you did, so it’s especially interesting and fun for me to hear about your beginnings. Despite abandoning your plans to become a high school teacher, you did, of course, become a college professor. Was that an easy choice when you finished your Ph.D.?

DS: Yes, it was a fairly easy choice, because I had wanted to teach at least since my high school days. As already mentioned, that was partly due to the teachers who had influenced my life. But, on reflection, I think there was more to it than that. In those days, especially in rural regions, teachers were looked upon as pillars of the community and valued public servants. Teaching was (and some of us think still should be) a noble profession. Even the salaries, although low, were not that bad in comparison to others in the small communities of my youth. Of course, I had planned to stay in one of those communities until my carefully laid plans were changed by being directed first to graduate school and then to Florida, where I found myself in another small town but a university town like I had never seen before.

So, the shift of interest from high school teaching to college teaching did not seem like a big deal at the time because I did not give much thought to things like long-term salary, work environment, travel opportunities, (writing AP rubrics), and so on. As it turned out, it was a big deal because I do not think I would last long in the high school teaching environment that has evolved.

Life is full of surprises and often someone is looking out for you when you are not even aware of it. With lots of help over the years, I've had wonderful opportunities to teach young people and, perhaps, have some small positive influence on their lives. That's what I was hoping for when I made those early choices.

AR: As a new professor on the track to tenure, how did you divide your time between teaching and research interests? Which courses did you teach, and what kind of research were you doing at the time?

DS: Let's start at the end of your question and work backward. My doctoral research was on aspects of sampling, but not the traditional sample survey designs that most statisticians associate with the topic. We were building models for what are sometimes called bulk sampling problems, like sampling raw sugar coming into a refinery to estimate pure sugar content, or sampling a vat of liquid to estimate the proportion of a specific chemical in the product or, perhaps, to see if the product is homogeneously mixed. The sample size might be specified in terms of weight or volume, say, rather than the number of discrete units (like people). So, you are filling up a continuum (a bucket, a core sampler or a test tube) rather than selecting *n* discrete units, and that makes sample size determination and the design of the study a little more complicated. This work lead to a series of papers in *Technometrics* in the late 1960s and early 1970s. Many of the applications were in the area of quality improvement at about the time Ed Deming was beginning to be recognized as having something important to say about quality in the United States, long after he had been recognized as a guru in Japan. In fact, I had the opportunity to discuss some of my work with Dr. Deming (when he was still accessible to a lowly assistant professor), which was a great experience for this new Ph.D. The work also led to a number of applied papers in engineering journals, and a number of consulting opportunities with industry and military establishments. The idea of filling a continuum rather than selecting discrete units, it turns out, had similarities to line transect sampling, such as running transects across a field to estimate weed coverage or placing grid lines over a cross section of a block of copper to estimate porosity. So, this broadened the research a bit to many other interesting applications in engineering and the biological sciences.

The Statistics Department of the University of Florida that I joined in 1967 was small. (We could all go to lunch in one large car, and that is the way we held faculty meetings.) So, each faculty member taught a wide range of courses. I taught everything from the introductory course for undergraduates to probability theory for graduate students, including engineering statistics, mathematical statistics courses for both undergraduate and graduate students, and, of course, sampling theory and methods. Teaching was supposed to be a half-time load, with research and everything else (committees, advising, etc.) packed into the other half, but I'm sure I spent more than half of my time on teaching. Remember, I always wanted to be a teacher, that being one of the reasons I chose an academic career, so I worked hard at trying to do it well. (On occasion, a student would tell me that I succeeded, which was always a great reward.) In those days a young faculty member could spend considerable time on teaching and still be on a successful track to tenure because teaching actually counted for something in the review process. I'm afraid times have changed; young faculty members these days are forced to spend almost all of the time they can muster on developing a successful research program, which seems to be about the only thing that counts in the reward systems of research universities. I think that is a change for the worse.

In fact, I could even spend time on textbook writing before gaining tenure, which allowed my research interest and teaching experience in sampling to lead to co-authorship of *Elementary Survey Sampling*, first published around 1975. The mathematical statistics book came shortly thereafter, again based on courses I was teaching at the time. So, teaching and research complemented each other, as they should, in such a way that I could use my time efficiently and effectively to enhance both aspects of my academic career. I was, indeed, fortunate in that regard.

AR: I want to ask about your early textbook projects, but first I can't pass up an opportunity to ask about your meetings with Deming. How did they come about, and what was he like?

DS: I met Professor Deming in the late 1960s, when he was in his late 60s and just beginning to be recognized by American manufacturing and business leaders, but while he still had plenty of contacts and prestige in Japan. I had a chance to observe these differing associations because we met at an East-West conference on quality and productivity at the University of Hawaii, attended by both Japanese and American statisticians and engineers. (Gene Taguchi was there as well, but I had no idea how famous he would soon become.) Clearly, Deming was admired by the Japanese, but some Americans were a bit put off by his criticism of management practices in this country and did not know quite what to make of some of his proverbs, like "Experience by itself teaches nothing."

Dr. Deming did not abide fools easily, and was not easily fooled. The conference had organized trips to local refineries for products such as sugar and chemicals in order for us to observe quality management practices at work. Typically, Deming would sit quietly through a presentation by an engineer, seemingly almost asleep at times, and then wake everyone up with a penetrating question. With degrees in mathematics, electrical engineering and physics, and worlds of experience, Dr. Deming often knew more than the engineer in charge about the practices being discussed, and could befuddle most of them with questions arising from his deep knowledge of almost any scientific process. (His emphasis on "profound knowledge" was not just a sound bite; he practiced it.)

Although tough and unyielding with regard to those in charge, Deming was kind and compassionate to those working at lower levels, including lowly assistant professors, and was always a gentleman in social situations. He took interest in my work on bulk sampling, giving me names of others working in similar areas and references to their published research. Among his other skills, he was a walking library. As is often the case with the inexperienced, I was not perceptive enough at the time to see what an honor and privilege it was to have discussions with this great man. I do not even have an autograph!

AR: Wow, a conference at the University of Hawaii sounds terrific in any circumstance, but getting to observe Drs. Deming and Taguchi up close must have made it really special. Let me *go back and ask about your first textbook projects. The sampling and mathematical statistics books that you mentioned are still widely used today, both in their 7th editions, I believe. Can you talk about how these books have changed over the years, and how the whole enterprise of textbook authoring and publishing has changed from your perspective?*

DS: The textbooks you mentioned both came out of lecture notes for courses that we were teaching at the University of Florida in the late 1960s and early 1970s. We had a large service course teaching program for undergraduates from a wide variety of fields, including engineering, the social and biological sciences, business and agriculture. In addition, we were trying to develop a strong undergraduate major in statistics. So, we needed a mix of theory and methods courses that could serve both groups. Mathematical statistics was an obvious choice, and there were textbooks available for the course. Most of them, however, were too heavy on the mathematical theory side and too light on the applications side. Sampling was not an obvious choice, but we saw a need for the course coming from a wide number of disciplines, and so we developed the course and wrote the book because there were no others available for such an introductory course.

I begin with this background to emphasize that both books were intended to present statistics as a useful, even necessary, science with wide and varied applications. So, how and why did these books change over the years? Applications and technology! Mathematical statistics itself has not changed much (as the book is not Bayesian in approach) but new applications appear and the approach to teaching the subject has been modernized with emphasis on applets and software (R, for example) both to demonstrate the theory and apply the theory to real-world problems. (This modernization is due to Dennis Wackerly, who has handled the revisions of this text for years.)

The basic sampling designs have not changed much either, but new ideas have been included from time it time, like adaptive sampling methods, and new applications abound. Computations in complex sampling designs are horrendous; this has now been alleviated with interactive Excel tools that allow both deeper understanding of basic principles and automated calculation in real studies. Of course, the move to include more technology is not a particularly novel idea, as that is the direction in which the whole field of statistics is moving. But, I hope we do it in such a way as to enhance the understanding of the subject as well as to expedite its application.

As to publishing itself, the major changes there are due to the same phenomenon: technology. In the old days, “cut and paste” literally meant cut (with scissors) and paste (with glue). Revisions were typed on a new sheet and replaced or added to the text pages by cutting up the pages and then gluing old and new back together in, hopefully, the correct order. A book that was about an inch thick in published form could become a foot-high stack of cut and pasted pages in the first stage of revision. And then all this was mailed back and forth to the editors via the U.S. Post Office, not the WWW. So, it was a painfully slow and often inaccurate process. What almost anyone now thinks of when they hear “cut and paste” is much the preferred way.

As to broader changes in the textbook publishing, wider uses of technology and the Internet allow for more specialized publishing of text material in up-to-date form, but also seem to require more ancillaries in the form of manuals on how to use the technology. This appears to be a good thing. Because electronic publishing is faster and cheaper, it seems also to require more ancillaries in the form of test banks, answers to exercises, teaching tips, and a seemingly endless list of "helpful" materials for the instructor. This may not necessarily be a good thing. The quality and educational value of a textbook should not be judged by the number of pages of ancillary material that come with it (or how many colors are used in its printing, for that matter).

I'm old enough still to enjoy the look and feel of a paper textbook in hand, but my breed is rapidly vanishing. (I still read a newspaper that is actually made of paper and delivered to my house each day.) It seems that before long almost all textbooks will be available only in electronic form. Nostalgia notwithstanding, I'll have to agree that it is the next logical step in publishing.

Involvement with K-12 Education

AR: Your interests and activities eventually extended to the introductory college course, as seen by your leadership of the Activity-Based Statistics *team and your co-authorship of* Statistics in Action, *and also to K-12 education. I want to ask questions in both of these areas, but let me start with K-12 education. How did you first become involved in this arena?*

DS: I had long been interested in education at all levels, including high school. (Recall that my first career goal was high school teaching.) In trying to teach introductory statistics to many, many students, it seemed to me that one of the problems was that we were cramming too much material (some of questionable value) into one course, all of which was completely new to the students. What if we changed the introductory course to something a little more student-friendly and useful? What if students had exposure to some of these basic ideas in high school? I had given a few talks to high school mathematics teachers in various venues, but the content tended to be watered down versions of the typical introductory course material, which itself tended to be watered down statistical theory. In retrospect, of course, it should not have been surprising that the teachers were not terribly receptive. I did not have any good ideas about how to change the things that I knew had to be changed.

In the late 1970s I was having dinner with the venerable Bob Hogg, who directed the conversation toward the work of a committee on which he served called the ASA-NCTM Joint Committee on the Curriculum in Probability and Statistics. The brain child of Fred Mosteller, the Committee had existed since the late 1960s and had published a number of works, including a set of innovative workbooks on elementary concepts in statistics and probability and the much better known *Statistics: A Guide to the Unknown*. He asked if I would be interested in serving on the Committee. As one does not often say "no" to the persuasions of Bob Hogg, I said "yes." It turned out, career wise, to be one of the most life changing "yeses" I ever uttered.

My first meeting of the Joint Committee was in 1980, held in Toronto primarily because the new chair, representing NCTM, was a high school mathematics teacher from Canada by the name of Jim Swift. I hope that someone interviews Jim for this series because he has had tremendous influence on statistics in the school curriculum throughout the U.S. and Canada, and he is little recognized for it. Jim had been turned on to the data analysis philosophy and techniques of John Tukey and had written data units for his high school students throughout most of the 1970s. Now, I had seen stem plots and box plots before, but Jim made them come to life. He was absolutely convinced that data analysis, with emphasis on graphical techniques, was the wave of the future and the wave that would capture the interest of high school students and teachers. Jim made lots of seemingly dull topics come to life, and was one of the most creative high school teachers (or people, for that matter) that I have ever met. Later, I discovered that he could do amazing things with a PC, a new tool at the time!

Swift, Tukey, and technology came together to capture my attention as the triumvirate that would change statistics education in a way that could prompt interest in both schools and colleges. I signed on for the long haul. Ann Watkins, also attending her first Joint Committee meeting at the same time, further convinced me that this was going to be an exciting ride. Ann is one of the most creative and knowledgeable college teachers I have ever seen and, as you know, one of my co-authors (or, I hers) on many projects over the years. Jim Landwehr came on the Committee a year later to add a deeper statistical perspective to our work, but I assume I'll get the chance to say more about Ann and Jim later.

So, K-12 education became a primary focus for my work, and still is in these years in which I am failing retirement. Going back to my opening statement for a minute, I asked about changing the introductory college course. Fortunately for statistics education in general, David Moore came along in a few years (late 1980s) with his video series "Against All Odds" and textbook on the "Practices of Statistics" that prompted those necessary changes, and fed nicely into our work at the school level. We were off and running, but many challenges were just around the corner – and some of those challenges are still with us.

AR: What is one challenge that you would say has been overcome? In other words, how is the teaching of statistics in K-12 better now than when you joined the fun (or should I call it a party, or a movement?) in 1980?

DS: To answer this question in some detail let me first comment on three significant early successes in this area. Members of the Joint Committee, challenged by Jim Swift and with many of his class activities as a starting point, wrote the original four booklets of the Quantitative Literacy series largely as a volunteer effort, but we had no money to disseminate our ideas and products to a larger world of mathematics educators and classroom teachers. It was suggested that we approach the National Science Foundation, a notion I would not have thought of because I related NSF solely to academic research. My doubts in check, I worked with Jim Landwehr and a talented, experienced mathematics educator from Michigan named Al Shulte, another huge contributor to statistics education who gets little recognition, to produce an NSF proposal centered around workshops for teachers and publication of our developing materials. To my surprise, our proposal was funded! So, for the next few years we were polishing our materials and running around the country like crazy giving three to five day workshops on something nicknamed QL. I should add that the Exploring Data module by Ann Watkins and Jim Landwehr was by far the most exciting and successful in workshops and in sales, as it presented captivating new ideas about data analysis that math teachers had never seen.

About this same time (1984) the Woodrow Wilson Foundation decided to fund four-week summer institutes for high school teachers, with the first one being in what they saw as a fairly new and important addition to the high school curriculum—statistics. Jim Swift was a key leader and I was one of the presenters, along with a host of others including John Tukey. Our participants were fifty of the brightest and most innovative high school mathematics teachers from across the country. To this day, that institute was one of the highlights of my teaching career. Many of those teacher leaders formed teams and, partially funded by Woodrow Wilson, organized workshops for other teachers literally from coast to coast. Some are still active in statistics education today.

The third dissemination arrow in our quiver was NCTM itself. During this time they were developing their "Curriculum and Evaluation Standards for School Mathematics," published in 1989, which, lo and behold, included a complete K-12 strand in data analysis, statistics and probability. The leader of that effort was then NCTM President John Dossey, a well-known mathematics educator who had a penchant for statistics (and who is still one of my heroes in this whole effort).

How have things changed? These three—the NSF funded workshops, the Woodrow Wilson funded institute and its aftermath, and the NCTM Standards—allowed QL to get off the ground and be taken seriously by many in mathematics education, including curriculum specialists, developers of materials, and teachers. Statistics (or data analysis) began appearing in state curriculum guidelines for K-12 mathematics, in new curriculum materials, on national assessments such as the National Assessment of Educational Progress (NAEP) and on programs of educational conferences like the annual meeting of NCTM. With regard to materials, my impression is that the success was greater at the elementary and middle school levels than at the high school level. In the first two, data analysis seemed to work into the curriculum quite naturally and become an interest-generating enhancement. This integration was much more difficult in the traditional algebra – geometry – algebra sequence of courses, but did become a reality in many of the integrated high school mathematics programs. Perhaps the most influential accomplishment of QL for high school mathematics is that it set the stage for the AP Statistics program.

In 1980 there were a few scattered statistics courses in high schools across the country and a few statistical ideas (along with a little probability) tossed into the K-12 curriculum here and there (often as the activity for Friday afternoon, after most students had already tuned out for the week). By the early 1990s statistics began to be recognized as a legitimate topic for K-12 mathematics that should be taught as a connected and coherent set of ideas. It was in the family, so to speak, but often seen as a poor stepchild that could be skipped over with no serious loss. In fact, that is quite common even now.

Creating AP Statistics

AR: You mentioned that the QL project set the stage for AP Statistics, so let's go there next. What was your first involvement with the possibility of creating an AP Statistics course?

DS: : Quite out of the blue, so far as I was concerned, I got an invitation from the AP Calculus Committee to attend one of their meetings in which they wanted to discuss statistics as an option for a second AP course in mathematics. Having never had the opportunity to take one, I knew little about AP courses, except that I heard some of the controversy as to whether or not AP

Calculus was a good idea, even for very bright high school students. On brief reflection, however, I decided this was too good an opportunity to pass up, as this might be a great way to get statistics into the high school curriculum in a structured way, as opposed to the haphazard appearances of statistics that were then the norm. So, one fine day in the spring of 1985 I showed up at the meeting in Philadelphia.

I was surprised to learn that the College Board had been considering statistics, along with discrete mathematics, linear algebra and multivariable calculus, as an option for a new AP course for some time, at least since the mid-1970s, but had some serious reservations as to what the content should be and whether or not students would take it. The Calculus Committee, particularly mathematicians John Kenelly of Clemson and Tom Tucker of Colgate, were very supportive of statistics as the best option and wanted to find ways to alleviate their concerns. Well, I tried to assure them that we could find a widely acceptable content outline that would cover the topics in most introductory statistics courses taught in mathematics or statistics departments, but I was not sure about who would take it (knowing little about what high school students actually did take in math after algebra). I must have been convincing enough to leave the door open because this meeting led to further discussions and studies over the ensuing ten years. Much of this early history is published in our *American Statistician* article of 2011, "Advanced Placement Statistics—Past, Present and Future." One of the quotes in that paper is taken from a 1987 report of the AP Calculus Committee:

> The AP program should not give secondary schools the mistaken impression that calculus is the only important mathematics subject at the introductory level.

That from the Calculus Committee! I knew I was going to love working with these folks, and that we would eventually be successful.

AR: That sounds like a pretty bold promise, to "find a widely acceptable content outline." How did you go about achieving the content outline and the consensus that you did?

DS: It was not difficult to find agreement among mathematics and statistics departments on what we might call an "opening agenda" on content for an introductory statistics course because, in those days, most of the popular textbooks had very similar content – some descriptive statistics, a little probability including the binomial and normal distributions, one- and two-sample inference for means and proportions. Even though regression was not covered in many introductory courses, we added that topic, along with the planning of studies, to the list sent out in surveys of mathematics and statistics departments. As I recall, there was not much disagreement on content, but a majority of the responding mathematics departments preferred another traditional mathematics course over a statistics course.

But the course outline distributed in surveys of the 1980s was not the one eventually approved in the 1990s. In keeping with the changes in the teaching of statistics mentioned above, the approved content outline for AP Statistics emphasized data – data exploration (including bivariate), data production, and inference, with enough probability to support the latter. Pedagogical emphases included active learning with appropriate uses of technology. We wanted to make sure the AP course had a data analysis flavor with broader and deeper content than would be found in most one-term introductory statistics courses in colleges and universities. We could not afford to error on the light side, come what may.

AR: Once the content outline was approved, what else was involved in getting AP Statistics up and running? Probably too many details to mention here, but what were the other challenges and how did you address them?

DS: Other issues centered around credit, students and teachers. The proposed content was OK with many of the mathematics and statistics departments surveyed, but college statistics courses, as we know, have homes in many disciplines and come in a variety of models. Who would give credit or placement for "the" college course that the AP course was supposed to replace? This was not a problem for calculus, as "the" first calculus course is almost always taught in a mathematics department. So, "Who is in charge of statistics at the colleges and universities?" was a concern for the College Board, a concern that has not been fully resolved to this day.

The second and related concern was, "If we build it will they come?" Will high school students sign up for an AP Statistics course, given that the subject was not even in the curriculum of most high schools of the day? In fact, will the credit question reduce the interest among high school students (and their guidance counselors)?

The third concern, then, was, supposing high school students are interested in taking the course, who will teach it? Are there enough high school teachers with interest and experience in statistics to build and maintain a quality program?

Of course, we never established rock solid answers to these questions, which delayed AP Statistics for a few years, but we eventually did provide strong enough arguments to convince an enlightened new leader of the AP program at the College Board to approve AP Statistics for implementation. This leader was Dr. Wade Curry, a psychologist with interest and experience in statistics and a person to whom those who love AP Statistics owe a great debt of gratitude. The seriousness of the first issue, credit, was mitigated by demonstrating that if we relied only on math and statistics departments to give credit for their introductory statistics courses, that reliance would cover a very large number of students from many disciplines. And that answer helped with the second concern as well, because enlightened high school students, teachers and counselors could see that many college majors were requiring such an introductory statistics course. Also, the modern content we had envisioned for the course was in line with the direction in which the college courses were heading (and did not require calculus).

Of the three major concerns, I find the third one, teachers, the most fascinating. We could only guess at the time that the interest in statistics at the school level generated by the QL project, the NCTM Standards, the Woodrow Wilson institutes and other related events, such as the quality improvement emphasis in industry, would help produce the lead teachers we needed in high schools across the land. As it turned out a few years later, great statistics teachers came out of the woodwork to make AP Statistics a success.

AR: I've met many tremendous teachers through my involvement with AP Statistics, so I certainly concur with you on that. Can you tell me and JSE *readers what was involved in writing the first AP Statistics exam? And also please talk about what I suspect was an even more daunting challenge: how did you go about* grading *that exam?*

DS: Let me first add a little on the preliminaries to actually writing the first exam. The partial answers to the concerns posed by the College Board, as discussed in my response to the previous question, were developed by the AP Statistics Task Force appointed in 1992. This led to a very satisfying response from Dr. Curry in late 1993; "I am pleased to announce that on October 1 the Trustees unanimously approved AP Statistics for implementation in either 1995-1996 or 1996-1997." At that point, an AP Statistics Development Committee was formed to finalize the course content, address teacher training, decide on the structure of the exam, produce a Course Description, produce a Teacher's Guide, AND write and field test exam questions. Probably our first unanimous (and quickest) decision was that all of this was not going to happen by the 1995-1996 school year.

Rather quickly, the content was tweaked a little but ended up much as described above, and not much different from the current content. It took much longer, however, for the Committee to debate numerous ideas on exam structure and policy, such as assigning materials (perhaps a large data set) to be studied before the test for certain questions, use of portfolios, use of calculators, providing a formula sheet, and so on. As you see, some of these ideas were adopted and some were not. Modeled somewhat after the calculus exam, the Committee eventually decided on the two-part exam still used today, with 30 to 35 multiple choice questions and about six free response questions, with one requiring an extended response.

Writing questions acceptable to the Educational Testing Service (ETS) staff responsible for the exam, statisticians and teachers was far more difficult and time consuming, I think, than anyone envisioned at the outset. (Good thing we were much younger and more energetic in those days.) After the Committee agreed on questions, the multiple choice questions had to be field tested in college statistics classes and assigned a level of difficulty. Free response questions had to have clear and relevant statistical content taking the fore over mathematical manipulation. So, some questions came back for review and rewrite a number of times. Often, the originator of a question did not even recognize it as his or her question by the time it was accepted.

Then there is grading! Early on, it became quite evident that we wanted the free response questions to be written so as to require a fully developed answer that demonstrated the statistical (or probabilistic) thinking that went into the process. In short, no questions with simple right-or-wrong numerical answers. But, open-ended statistics questions usually have multiple paths to acceptable answers. So, the question was how to grade with fairness to these multiple paths and, in fact, to encourage students to think outside the box. The answer came, as I recall, through conversations with the long-time ETS leader for AP Statistics, Jeff Haberstroh. Jeff had experience with other disciplines that used something called holistic scoring, scoring based on a student demonstrating not only comprehension of the parts but also how the parts interconnect to the whole. In other words, we agreed that in order to receive full credit a student had to demonstrate clear and correct statistical reasoning throughout and communicate a sound conclusion that related to the original question in context.

Consistent scoring of holistic responses requires graders to use a detailed rubric that explains the various correct approaches that a student might take, as well as pointing out the typical incorrect responses, and then assigning what amounts to a categorical score rather a numerical one (although the categories get turned into numbers). The notion of scoring rubrics was difficult for the Committee members because most of us had never used holistic scoring. "Rubric" sounded like a foreign word (Russian money?) that was not in our every-day vocabulary, but it soon became an everyday buzzword. With lots of experience gained by writing and rewriting rubrics, the Committee honed the system into a workable one that seems to have not changed in substance over the years of AP Statistics exams.

The first AP Reading in 1997 had, as I recall, 50-some readers, split between high school and college teachers, with a few more of the latter in the early years. It was more difficult to recruit college teachers because, for them, this was an extra duty for which they received no professional reward. High school teachers embraced this reading with the same great enthusiasm they had about the course itself. With what we learned from the always-helpful AP Calculus Committee and from the ETS staff, especially Jeff, the Committee, augmented by additional recruited leaders, pulled off the first Reading with few hitches. We thought that was quite an accomplishment, but in retrospect it was small potatoes compared to the Readings of recent years that require a ten-fold increase in readers.

Standards for K-12 Curriculum

AR: I think it's a great tribute to the work of you and the early committees and grading leadership team that so much of what you put in place is still in effect. I also think that the AP Statistics course has played a substantial role in helping college courses to focus more on data and to implement better assessment methods. I could ask many more questions about AP Statistics, but I'll leave that behind and ask about K-12 education more broadly. You mentioned earlier, before I led (hijacked?) our conversation down the AP Statistics path, that the 1989 NCTM Standards included a complete K-12 strand in data analysis, statistics and probability. Did you play a role in that?

DS: Short answer for a change. No. Well, perhaps that's too short. I played no direct role, but the QL team had contact with John Dossey, as mentioned above, while he was president of NCTM (1986-88). By agreeing to present introductory remarks about the importance of statistics in the school curriculum, he lent his prestige to a video we produced to provide an overview of the QL program to a wider audience of teachers and administrators. So, he knew about QL and was happy to promote it at NCTM, and promote statistics (data analysis) as an integral part of the Standards. There were other teachers active in the QL program who were also active in NCTM at the time, most notably Gail Burrill (a later NCTM president). QL was a product of the ASA-NCTM Joint Committee, and we had great support from NCTM throughout the life of the project.

AR: I know that you played a role in the development of the ASA-sponsored GAISE guidelines for PreK-12, which were adopted in 2005. How did the GAISE process originate and evolve? What do you think these guidelines offer that the NCTM Standards do not? Are you satisfied with the impact that the GAISE report has had?

DS: I'm not the best one to ask about the origin of GAISE, as I was only one of many writers. I was invited to participate by Joan Garfield and Chris Franklin after they, and a few others, had thought up this idea of writing guidelines for both school and college statistics teaching. I think

Jeff Witmer (clever as he is) actually came up with the title. I chose to work with the K-12 side, as that's where my passion was at the time, and still is. As the project evolved, a large number of smart, clever and experienced statistics education activists were added to the writing groups and it became a really fun experience working as a team (if writing and rewriting multiple drafts of the same document can ever be called "fun"). Even with much back and forth communication within and among writing groups, the final version emerged in a relatively short period of time, although it has been revised once since then.

GAISE is much different from the NCTM Standards and serves a different purpose. The Standards contain a fairly narrow list of topics with brief explanations and a few simple examples, whereas GAISE introduces a deeper and broader view of statistics with much more explanation, teaching hints, and a multitude of good examples. The first Standards document brought an awareness of data analysis principles and procedures to the mathematics curriculum; GAISE brings an understanding of statistical thinking from data exploration through inference and a rationale for statistical science as a key part of the quantitative world. But, we must not lose sight of the fact that the early version of the Standards was immensely important in building support for data analysis in the mathematics curriculum; without it we may never have gotten to the point at which GAISE was viable.

At first I was skeptical about the GAISE project with respect to its potential impact. I thought it might be a nice set of guidelines for ASA to have in its education arsenal, but was not sure that the arsenal provided any real firepower. I was wrong! Even before its impact on the Common Core State Standards, GAISE has had impact on state standards, other sets of standards such as those developed by the College Board and ACHIEVE, teacher education programs, assessment projects in statistics education, and other areas. I'm more than satisfied with the impact of the K-12 report, and with its potential for even greater impact in the future. I have not followed the trail of the college report so do not know of its impact, but I have encouraged the writers of the revised report on *The Mathematics Education of Teachers*, coming soon from the Conference Board of the Mathematical Sciences (CBMS), to reference this as the standard in teaching introductory statistics.

AR: Let's talk next about the Common Core State Standards. My understanding is that the Common Core is a really big deal, bigger than any of the other important initiatives that we've discussed so far. Do you agree with that? If so, what makes the Common Core such a big deal? Also, please tell us about your involvement with this. And finally, as if I haven't crammed enough questions into this one question, perhaps the most relevant one for us: How does statistics fare in the Common Core?

DS: How big a deal the Common Core State Standards (CCSS) will be is a matter of great debate in education circles right now. Some say it has the potential to significantly improve both the content and pedagogy of mathematics education in this country and foster a resurgence of interest in mathematics not seen since Sputnik. Others say it has the markings of another government boondoggle such as occurs regularly when government ventures too far into education. Common Core is simply a set of standards that individual states are free to adopt or not, as they see fit. (The adoption list includes 47 states, at this writing.) Even for a state that says it is adopting CCSS, there are many ways in which that state could develop its curriculum around them. A broad range of experts ranging from research scholars to teachers have put a great deal of careful work into the project, with wide vetting among many constituencies during its development. In short, I think CCSS has the potential to improve mathematics education because it is a well thought-out set of no-frills standards that are narrower in focus but deeper in content than can be found in most state standards today—and they have the support of many professional organizations, including ASA and NCTM, as well as the states. How effective CCSS will be depends on how the standards are interpreted by the states and how effectively that interpretation is carried into the taught curriculum, but I am cautiously optimistic.

As to government involvement, let's be clear about who is responsible for CCSS. The initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). It is not a federal government project, but federal dollars do help fund the assessment projects that are now running on parallel tracks. Even though the standards themselves were released some time ago, there are numerous support activities, in addition to assessment, which are still open to suggestion from interested parties. You can read about progressions (narratives that flesh out how the standards can be woven into a connected curriculum) at http://commoncoretools.me/ and illustrative tasks that illustrate the standard, a project to which anyone can contribute, at http://illustrativemathematics.org/.

No frills? Well, some, even some of the writers of the document, would say that there is a frill in CCSS, and it is called statistics. A short while after the start of the Common Core initiative I was asked to comment on some of the statistics (or data analysis) standards they were considering and offer suggestions for improvement. I had done similar work for ACHIEVE, another entity created by the NGA, in their development of guidelines for mathematics education, and the lead writers of CCSS had been part of the ACHIEVE advisory group. Well, as things happen, before I gave much thought to the implications of all of this, I was on the CCSS writing team and helping to write statistics and probability standards. (Naivete´ is probably not the best way to make life decisions, but it leads to some interesting challenges.) Suffice to say, there was lots of opposition from writers and reviewers about including much (any) statistics and many reviews and revisions along the way, but the lead writers, to their everlasting credit, were always 100% committed to having statistics and probability standards at least from grade 6 on. The end result is that there is little overt reference to statistics in grades K-5, although there are references to data that can be tweaked toward statistics, but rather strong sections on statistics and probability in the middle and high school grades. Some of our statistics colleagues do not agree on the "strong" part, but I still think that is an honest characterization given the current content of state standards and the competition for topics to be included in CCSS.

Given the flexibility in implementing the Common Core and the fact that the statistics components of 6-12 standards are beyond what many teachers have studied or experienced, statistics educators can play a crucial role by paying attention to what is happening in their states and school districts and finding ways to help support sound implementation.

AR: It seems that two important things that are needed are development of curriculum materials with which teachers can teach the statistics and probability topics in the Common Core, and *professional development for helping those teachers to learn the statistical ideas themselves. Do you know if much is happening at this point on these two fronts?*

DS: I know little about materials development specifically related to the Common Core at this early stage. What will happen, and probably is happening already, is that publishers will see the standards as a list of topics, show that their materials mention these topics somewhere, and then claim that their materials are suitable for teaching the Common Core. This should be deemed unacceptable by materials selection committees! Both of the organizations (PARCC and SMARTER Balanced Assessment) funded to build assessments of the Common Core have suggestions as to how the standards might fit into curricula, but they are not materials developers. One way for interested parties to help supply exemplary material for teachers and others to flesh out the standards is to contribute illustrative tasks, as mentioned in the preceding answer.

Teacher education is a critical area on which the success of CCSS depends. There are two branches to this, the college education of pre-service (prospective) teachers and the professional development of in-service teachers. Many groups are thinking about this, I suspect, but the one that I know most about is the CBMS team revising *The Mathematics Education of Teachers*. This document, which may be published by the coming summer, gives recommendations for the content and pedagogy that teachers need to know in order to teach the Common Core effectively, along with serious suggestions as to how this might come about. Of course, the report is mainly about mathematics and written for mathematics departments, but statistics plays a larger role than in most such documents written for the math community.

Teacher education seems not to be on the radar of statistics departments, with a few notable exceptions like the University of Georgia under Chris Franklin's leadership. I know of very few efforts specifically directed at revamping introductory college statistics courses for teachers so that their education gives them the depth of statistical knowledge and pedagogical skills (active teaching with appropriate technology) to teach the Common Core with authority. This must change if teachers are to receive the kind of statistics education that future K-12 programs will demand, and I sincerely hope this change comes about with the GAISE college report as a model.

AR: How much of what we college folks teach in a standard "Stat 101" course is included in the Common Core standards? Do you think that within 5-10 years we can start expecting students to enter our college courses with a fairly sound grounding in what we're now teaching in Stat 101?

DS: The Common Core standards are not intended to replace any part of a college course (or even an AP course), but are intended to provide high school graduates with a foundation in mathematics and statistics that better prepares them for college, other types of post high school training, or the job market. The middle school standards emphasize data exploration and elementary probability, with an introduction to random sampling. The high school standards go deeper into bivariate data exploration and modeling, making use of simulation to study the inferential concepts of margins of error and p-values.

So, in the best-case scenario, you might spend less time in "Stat 101" on data exploration, measures of center and spread, or basic probability, but inferential reasoning will still be fuzzy and none of the classical inference methods of estimation or significance testing will have been covered. One positive note is that students may be more adept at using simulation for studying concepts and for inference, as it will have been a basic tool in the school approach; this experience may allow the typical college introductory course to go a little deeper into statistical thinking.

Hopefully, the CCSS will provide students with an awareness and appreciation of statistics, improved quantitative reasoning skills, and an understanding of basic concepts that will help them in future studies or work. I would also hope for an attitude of excitement about statistics that will encourage them toward deeper study of the subject, but that may be aiming a bit high.

More Curriculum Projects

AR: I want to ask a few questions about undergraduate teaching of introductory statistics. I have yet to mention two of your most influential projects: Activity-Based Statistics *(*ABS*) and* Statistics in Action *(*SIA*). Let's start with* ABS*: How did this project come about?*

DS: As is the case in most of the statistics education projects in which I have been involved since 1980, much of the impetus came from the QL experience. That project emphasized active learning with hands-on experiences for students, and some of us (particularly Ann Watkins, Mrudulla Gnanadesikan and I) thought these ideas should be part of the statistics education experience of college students as well. I then had some conversations with the Springer statistics editor, who I had known for a long time, about building a sort of lab manual for statistics courses around activities. He suggested putting something together to show him what we intended, and that led to the first edition of ABS, which was published by Springer but later marketed by Key Curriculum Press.

But a lab manual covering much of introductory statistics required many more activities than we could scrap together out of QL. In looking for clever ideas, I thought immediately of Jeff Witmer, a former faculty member at UF and an innovative teacher, and Jeff eventually contributed so many great ideas that he became a co-author. We borrowed not only from QL ("What is a Confidence Interval"), but also from other creative teachers like George Cobb ("Gummy Bears") and from those using statistical ideas in quality improvement ("Funnel Swirling"). I knew from my sampling experience that size bias was a big problem and that led to "Random Rectangles," which turned out to be one of the most widely used activities. We even introduced randomization tests and bootstrapping to a larger audience.

The many contributors to the project, the major ones listed as our Advisory Committee, helped ABS reach a fairly wide audience and have some impact on statistics teaching both in high schools and colleges. Seeing this work, teachers began to think more deeply about hands-on instruction and began to create their own activities, which may have been the most valuable spin-off. I'm happy that the materials are still available, and that I still receive questions or comments about particular activities from time to time.

AR: I suspect that "Random Rectangles" is the most widely used activity for teaching statistics of all time, at least among activities that do not involve M&M candies! Let's turn to Statistics in Action*, which now goes by the title* Statistics: From Data to Decision. *What led you and Ann and George to write this textbook, and what would you say makes it distinctive from others?*

DS: I should have patented "Random Rectangles."

Once we had the AP Statistics course up and running, with Ann playing key roles on both the feasibility task force and the initial Test Development Committee, we bandied around the idea of writing a book for the course that would build on the best of the ideas we had learned through QL and ABS. George became part of the discussion because we both knew him as a very deep thinker on statistical reasoning (and most everything else) as well as an innovative teacher and a good writer. (Who else would have come up with the gummy bear activity?) It took a long time for these plans to gel, and an even longer time to actually complete a textbook. I no longer recall how we settled on Key Curriculum as the publisher, but I'm sure it had something to do with our ABS experience.

Our idea was to introduce the basic notions of statistics up front, and then build on that throughout the book, with clear explanations of the statistical reasoning at each step. So, we introduce a real situation and analyze the pertinent data in Chapter 1, using simulation as the tool for introducing inference. A little later we emphasize that no statistical analysis will overcome bad data, and spend a fairly long chapter on the design of studies. All chapters build in hands-on learning with specific activities for students. Discussion problems and practice problems precede the deeper exercises, some of which stretch the learner a bit. These comprise what I would call the major distinguishing features. Of course, some users say the book is easy to read and the extended explanations are helpful; others tend to ignore the reading and go straight to the formulas. In similar fashion, some like the embedded activities and some say they are too time consuming. So, we seem to have a ways to go to get some instructors to buy into the idea of active learning in the statistics classroom, or laboratory, but we keep trying.

AR: You mentioned earlier, when we were discussing the GAISE project, that you chose to work on the K-12 side rather than the undergraduate aspect, because K-12 education is where your passion lies. Maybe it's unfair to ask anyone to explain why their passion lies in one direction rather than another. But you've done so much with both K-12 and undergraduate education that I'd like to invite you to talk about why your passion lies with K-12.

DS: I've never thought much about this, but I suspect the first real motivator for working with school mathematics was my abiding interest in teachers and teaching (my first career goal, as you might recall). The facts that most teachers are dedicated to their profession, work long and hard, and receive little support from administrators, parents and the public are not new; they have been present for a long time. The facts carry extra weight in mathematics, which is deemed by many to be a dull subject that most people do not understand and rarely use (the brunt of most jokes about education). So, I wanted to help teachers enliven their mathematics courses, and perhaps their own lives, by introducing some really fun, interesting and important stuff about statistics and probability.

My passion to improve teaching and curricula was given more focus by seeing first hand the results of school mathematics demonstrated by the weak quantitative skills possessed by otherwise bright students coming into my introductory statistics courses. Not only did we have to make mathematics more interesting, but we also had to make it more vital by teaching the quantitative reasoning skills that are necessary for life in the world of data and technology. Of course, this was the passion flamed by Jim Swift and Ann Watkins, among others, in the early days of the QL project. The recent experience of the bursting housing bubble driving down the economy is a dramatic example that we have failed to accomplish this so far, but we are making some progress.

I love the profession of statistics and have never regretted choosing it as a career, so some of my interest in promoting statistics in the schools was to increase the awareness of statistics as a discipline, but that was never the real driving force. I do think, however, that AP Statistics has produced that awareness among some groups of students, to the benefit of all of us.

Pop Quiz

AR: Now we begin what I'll call the "pop quiz" segment of the interview, where I'll ask very specific questions and will ask you to limit your responses to 2-3 sentences per question. First, what hobbies do you have outside of statistics and education?

DS: I'd like to think I'm somewhat of a household handyman and gardener, as I enjoy working around the house, inside and out. I enjoy reading, mostly history and biographies, listening to classical music (and some others but not rock), watching old movie classics, hiking nature trails, especially in the mountains and forests, and playing the occasional golf game (but both my clubs and I are getting rustier every day).

AR: I have to follow up by asking to name some of your favorite classic movies. Then the next question on the pop quiz script is: What are 1-3 books that you've enjoyed reading in the past year? (You can have 2-3 sentences for each of these.)

DS: Favorite movies include the popular classics like *Casablanca* and *On the Waterfront*, most anything Hitchcock like *Vertigo* and *Rear Window*, classic performances by great stars like *High Noon* (Cooper), *East of Eden* (Dean), and *To Kill a Mockingbird* (Peck), and many early but lesser known performances by great stars like *Ace in the Hole* (Kirk Douglas) and *The Mission* (Robert De Niro). But this only scratches the surface, as there are lots of great movies still on the "to be seen" list my wife and I have put together. I must work less on statistics and more on movies!

As to books, I enjoy any biography by Walter Isaacson, and his recent *Steve Jobs* does not disappoint. On the history side, I enjoyed Ron Chernow's *Washington.* Being interested in religious history, I found the James Carroll book *Constantine's Sword* quite informative, but anyone reading the latter needs to read *Defending Constantine* by Peter Leithart to balance the equation. As with the movies, there are many books on my "to read" list, so I must develop a better plan for reading between movies.

AR: Thanks for squeezing in time for my silly pop quiz in between movies and books and statistics! Next question: What are 2-3 of your favorite places that you have traveled? Maybe you could mention one place that you've traveled for professional reasons and one that was purely for pleasure.

DS: One of the great benefits of being a statistician is the opportunity to travel all over the world, as all parts of the world seem to hold statistics meetings of one type or another. Two of the most fascinating for my wife and I were China (austere but organized when we visited in 1987, before it became a popular tourist spot) and India (relaxed and open but chaotic). Our favorite may be New Zealand because of its astoundingly diverse beauty, including its people; we could easily adapt to living there. Closer to home, we love visiting the western North Carolina mountains, rather different from Florida, to hike their gorgeous mountain trails to plentiful waterfalls. Well, that's four, but close enough for a statistician.

AR: Speaking of exotic travel, I believe that you and I first met at the International Conference on Teaching Statistics (ICOTS) in Marrakech in 1994, my first overseas trip. You mentioned your wife; please tell us a bit about your family.

DS: My lovely and wonderfully supportive wife, Nancy, once one of those high school teachers I spoke of admiringly, taught science and English during my graduate school days and then gave up that career for the more important career of motherhood. She later worked for the March of Dimes, and still spends much time volunteering for service organizations and the United Methodist Church. We have been friends since junior high, started dating in college, and celebrated our 48th anniversary in December 2011. She kept the home fires burning (and still does) during those times when I was running around the country, mostly to places not of the exotic variety mentioned above, trying to convince folks that statistics is important.

We have two children and three grandchildren. Our daughter Luanne is married (Danny) and has a son, Zachary (6). They now live in sunny St. Petersburg, FL, after many years in southern California (she loves the beaches in both places), where she is a merchandise planner for the Home Shopping Network. Our son David is married (Patty) and has two daughters, Hannah (13) and Emma (10). They live in the "sportsman's paradise" of northern Louisiana (he, too, loves hiking in the woods), where he is an occupational therapist.

My life has been blessed in many ways, but, most importantly, by a loving family who contribute in significant ways not only to my life, but also to the lives of many others.

AR: Name something that JSE *readers will probably be surprised to learn about you.*

DS: I like trains and have collected model trains since receiving my first Lionel when I was ten years old. I prefer the steam engines, and my latest is a model "Polar Express," which our grandson loves. Now, you cannot like old trains without liking old country music (one of the "others" I mentioned above), the really authentic stuff from the likes of Roy Acuff and Hank Williams, and maybe even early Johnny Cash. Where I was growing up in the hills of PA the death of Hank Williams at age 29 was a day of mourning, as well it should have been.

AR: That's terrific. I'm definitely surprised, and I bet others will be too. Let's return to a travel-related theme, and I promise that this will be my most fanciful question of the interview: Imagine that you can have dinner for four with anyone you'd like, anywhere in the world. Who would you invite, and where would you go?

DS: Only three guests? That's a difficult choice, so I will stay clear of those with whom I have worked in recent years because I have had wonderful dinners, and dinner conversations, with so many of them. I would invite Jim Swift, the clever and imaginative teacher I talked about earlier, who can engage us in discussions of mathematics and statistics education but can move just as easily to poetry, art, music or any number of other subjects. Then, I would invite Bill Clinton—yes, THE Bill Clinton—who can talk authoritatively about almost anything. If Clinton cannot make it, which is most probable, I would invite Henry Pollak, a less familiar name to JSE readers, no doubt, but a remarkable mathematician, engineer and scientist who, after an illustrious career at Bell Labs, devotes his "retirement" years to mathematics education, emphasizing a mathematical modeling approach that includes probability and statistics. Now, this cannot be an all male group, so I would invite Janet Norwood, the first female director of the Bureau of Labor Statistics and one who inspired many women to consider careers in statistics. (Janet is my living choice, knowing that Gertrude Cox cannot come.)

I need these wonderful conversationalists because I want to go a long way to have dinner, all the way to the fascinating rocky hills of Cappadocia in central Turkey. Over thousands of years, collections of houses and even complete cities have been carved into these hills. (In the early Roman Empire many of them served as hiding places for Christians.) One of my most memorable dinners ever was in one of these caves then serving as a restaurant. The location, the food and the entertainment, complete with a belly dancer, were all, to use a cliché, "out of this world." When do we leave?

AR: I wish I could make that happen, but instead let me return to more practical issues: What was your favorite course to teach?

DS: I have taught just about everything from undergraduate introductory courses for all comers, to service courses for graduate students in other disciplines, to theory courses for doctoral students, but my favorites were two kinds of introductory courses. At the undergraduate level, I liked the introductory course designed for social sciences students, which really meant any students outside of the STEM fields. At the graduate level, I also liked the introductory statistical methods courses designed for students from a wide number of disciplines. Although not the best quantitative minds on campus, these students were open to learning about applied statistics from a practical point of view and to examples from a wide variety of fields. In other words, interacting with them was fun.

AR: The theme of the USCOTS conference held last year, at which you were presented with the USCOTS Lifetime Achievement Award, was "the next big thing." What do you think the next big thing in statistics education is?

DS: Whatever it is, it will involve technology, the real powerhouse behind the recent changes in statistical practice and theory. We seem to be making progress with randomization methods, as they are now at least mentioned in some introductory courses (where they work well for demonstrating the basic tenets of statistical reasoning) and developed further in some theory and methods courses. These computational intensive methods should become a standard part of the statistics curriculum, introduced at the school level and expanded at the undergraduate and graduate levels, especially for those choosing a career that will involve the practice of statistics. The expansion should include Bayesian methods and a selection of techniques that have come to be popular in data mining, such as clustering, classification, and cross validation.

All of this will require better ways of teaching with technology, but I'm sure great progress will continue to be made in that arena.

Parting Thoughts

AR: I'm down to my last few questions, and I greatly appreciate your patience. I can't conclude without asking about your experience as President of the American Statistical Association in 2001. What did you learn about the ASA, or about our discipline, through that experience?

DS: I learned a lot about airports around the country, and in the process met a lot of very nice people working in the statistics profession. And people were the most exciting and positive part of my experience, as I got to meet a host of dedicated professionals who were excited about statistics across a wide variety of careers in education, business, industry, and government. It was comforting to find that statisticians generally were quite happy with their chosen field of study and work.

That is not to say that everyone was happy about all the things happening, or not happening, at ASA. This was over a decade ago, so my memory is a little fuzzy and many things have changed at ASA since that time, but there were differences of opinion between university faculty and those working in other arenas. University faculty seemed satisfied with the journals and meetings sponsored by ASA because they provided opportunity for them to publish their research and share talks with colleagues, whereas statisticians in business and industry working in more applied areas found less opportunity to either publish papers, share ideas or improve skills necessary for their jobs. The latter group was turning to other professional associations to meet their needs. It appears that a richer variety of continuing education courses and special topic meetings, along with broader programming at the JSM, may have stemmed that tide a bit.

As to K-12 and undergraduate education, there was little that ASA offered at the time except through activities of the Section on Education, composed mainly of teachers of undergraduate statistics. This Section has expanded in both numbers and quality of programs over the decade, and much more attention has been given to ASA programming for K-12 teachers (like the Meeting Within a Meeting and the continuing BAPS sessions). Similarly, ASA's support of *Significance* provides a boost to their education agenda.

I also discovered that ASA has a LOT of committees, most quite active and composed of dedicated and diligent volunteers from the profession. It is not unusual for a president-elect to make more than a hundred committee appointments, and I have to say that, in my case at least, the response from the membership was magnificent; very few people I contacted about serving on a committee refused to serve. I think statisticians in general have a positive attitude toward service, perhaps because they have already chosen a field in which much of the work is service to the interests of others.

I count it as a great privilege to have been elected to serve as an ASA president; it was, overall, a wonderful experience.

AR: Speaking of leadership, I'll never forget what George Cobb said about you in his USCOTS presentation in 2005: "Dick's leadership is of a stealth variety: his radicalism tends to fly beneath your radar. He is invariably unassuming and friendly, never preachy. He presents radical ideas in the modest spirit of 'Here's something neat that you might want to try.'"

My next-to-last question: Among your many accomplishments in statistics education, which one (or two, if you insist) are you most proud of?

DS: I really appreciate the comment from George, especially since he is one of the clearest, cleverest and deepest thinkers about statistics education and related issues that we have in the profession today.

Most of the education projects and ideas I have worked on over the years are interconnected in a sort of network in which each supports one or more of the others, and it's hard to see what would have happened to the network if one or more were missing. As outlined earlier in this discussion, the QL project helped AP Statistics become a reality and AP Statistics had some influence on college teaching of statistics. In turn, both the importance of and demand for statistics in undergraduate education and the success of the AP program strengthened the case for statistics in the Common Core and other standards, as well as in some integrated mathematics curricular projects, at a time in which the interest in statistics as an integrated part to the mathematics curriculum was ebbing away.

So, I would have to say that I am proud of the network of statistics education projects in which I was privileged to have had a hand. But I must quickly add that I was not the owner of any of the projects in the network. QL was brought together by an innovative team of statisticians and teachers on the ASA-NCTM Joint Committee, AP Statistics was birthed by the AP Calculus Committee, the GAISE initiators were way ahead of me in their thinking, the Common Core has so many contributors that they are almost beyond counting, and even the textbooks with my name on them include other names as well. A lot of success in life is fortuitous; I happened to be in some good places at the right time, for which I am sincerely grateful.

AR: All of us who are trying to follow in (some subset of) your footsteps are also very appreciative. Finally, what advice do you have for JSE readers who are fairly new to statistics education?

DS: Many of the young people I've met who have an interest in statistics education appear to be pretty sharp, and probably do not need advice from me, but I'll take up on your offer and provide some anyway.

Pay attention: Many educational issues and efforts at the forefront of discussions today, be they in schools, colleges, business or government (or all four), have statistical implications. Find out what is going on locally, nationally and globally that is or could be related to statistics education. Does your high school teach AP Statistics? Is your state a Common Core state? If so, how are teachers to be educated to teach the statistics component of those standards? Is the statistics program in your college up to date in content and delivery? How do businesses and/or industries in your area handle quality improvement issues? What about the quality of those sample surveys your local government keeps relying on? I include the last two questions because I'm convinced that practical experience outside of the classroom helps improve teaching, in addition to increasing the support base for statistics education.

Get connected: Read journals like JSE and SERJ (*Statistics Education Research Journal*) to see what others are doing, and even contact some of the authors about work you find appealing. Attend meetings like the JSM or ASA Chapter meetings. Become part of CAUSE or the isolated statisticians group, or whatever groups might be appropriate for your interests.

Be proactive: Speak up. Once you find an area that interests you, do not wait for an invitation to be involved; volunteer. Do not be shy about sharing your ideas with others, even if some of the others have gray hair. Age does not absorb all the wisdom in the world, and statisticians tend to be quite open to new ideas. If you are asked to serve, say "yes." (My positive response to Bob Hogg's question about joining the ASA-NCTM Joint Committee changed my career.)

Enjoy the ride: Statistics is fun!

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