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The recent article by Meng (2009a) continues a long tradition of articles in this journal dealing with the future of statistics and statisticians. For over 25 years many of these accounts painted varying shades of the same grim picture—that our continued existence is under threat; the challenges are great; respect has been in short supply; and our future is bleak. In this article I suggest we spend less time scanning the cross-disciplinary borders for new intrusions and rather than shoring up the fortress, we open up the borders. I share Meng's upbeat enthusiasm for a bright future while recognizing much remains to be done to increase our relevance and effectiveness.

KEY WORDS: Accreditation; Communication; Future of statistics; Outreach; Statistical education.

1. INTRODUCTION

The article by Xiao-Li Meng (2009a) resurrected some old chestnuts about the relevancy of statistical science and statisticians. Following what seems to be a well-established tradition, I chose a title that poses a rhetorical question about the future of our profession. Loosely translated it means “*where to* or *what's the problem?*”. While I believe it is healthy and appropriate for any organization to periodically engage in this sort of contemplative and reflective ‘naval gazing,’ there is a risk that introspection without intervention can lead to paralysis. Constant questioning of our worth, relevance, roles, function, and esteem with which others view us can undermine our self-confidence to the point where we lose our ‘sense of place’ and become unsure of our *raison d'être*. Perhaps I am overstating it, but for as long as I can remember our profession seems to have been constantly searching for its ‘place in the sun.’ For me, the journey as a professional statistician has been, and continues to be, an exhilarating one. I could not have imagined that 37 years ago when I first enrolled in my undergraduate degree program that I would subsequently find myself working side-by-side distinguished scientists as a valued member of multidisciplinary teams. Nor did I envisage that my chosen profession and interest in its application to environmental protection would see me flying down remote and mountainous river gorges in Papua New Guinea or snorkeling over seagrass meadows in pristine waters off the coast of Western Australia.

There was a time when I believed that the role of an applied statistician was purely a supportive one—a bit like the ground crew that dutifully pulls up the rear in the Tour de France ready

to provide assistance in case of a crash. During this period I remember reading a number of articles that sought to define what it means to be a statistician. One in particular left a permanent impression—not because it inspired me, but rather because it scared me. ASA past President Jon Kettenring's olfactory system was clearly on high alert when in 1996 he claimed “we smell trouble all around us.” His statement (Kettenring 1996) that “other disciplines have been seizing opportunities that should have been ours” was, in my view, nothing more than naked paranoia. Thirteen years down the track and Meng (2009a) has reissued the apocalyptic warning that we still “have much to worry about or even to fear.”

Rather than heed the call to arms and attempt to wrench back what apparently is rightfully ours, I decided a more effective strategy was to ‘embed’ myself in the research projects of others and to work from within to win over the nonbelievers. This was coupled with the provision of statistical training that was hands-on and delivered *in the context of the target discipline*. It was, as they say, ‘hard yards’ in the beginning and required a sustained commitment, but ultimately the strategy proved successful and I now find myself *directing* large multidisciplinary, multi-agency environmental projects as opposed to simply having cameo roles.

2. XENOPHOBIA?

Like many before him, Meng (2009a) challenged us to think about our future; to contemplate the possibilities; and to ask ourselves if we have the collective ‘ticker’ for “such a nerve-racking task.” His introductory comments and scene-setting quickly moved to the next section headed by yet another rhetorical question: “what should be our deepest fear?”. My immediate thought on reading this was “*a lack of confidence in our own abilities*.” To his credit, Meng (2009a) focused on the positives and provided many fine suggestions for ‘lifting our game’ and while I certainly wouldn't wish to detract from this enterprise, I am nevertheless struck with a profound sense of *déjà vu*.

In his Presidential address delivered on the occasion of this society's 141st Annual Meeting in Detroit in 1981, Ralph Bradley asked “what then is wrong with statistics and what should we do for its future?” (Bradley 1982). Noting that the shortage of doctorates in statistics “seems likely to reach a critical level in the very near future,” Bradley's (1982) solution of attracting and retaining the best and brightest was, in the absence of a *strategy* for achieving this, yet another documentary on the apparent crisis in statistics rather than a survival guide for the future. In the same speech, Bradley emphasized “statistics as a science” and posed the question “have we failed to understand that experimentation and statistical analyses contribute only part of the information that goes into decision making?”. Almost 20 years later, John Nelder warned us that “the public image of statistics is poor and may be becoming worse” and

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suggested that one of the biggest problems was the word ‘statistics’ itself (Nelder 1999). Like Bradley, Nelder (1999) was keen to establish a nexus between statistics and science, arguing that we should describe our discipline as *statistical science* rather than simply statistics. This was not a new suggestion and indeed Ruberg and Mason had promoted the same idea 11 years earlier (Ruberg and Mason 1988). Advance the clock to 2009 and we still find ourselves referring to our profession as ‘statistics’ and discussing ways to combat the perceived threats to our existence.

I found the Nelder (1999) article compelling reading at the time and even now as I refer to it for this correspondence, I am struck both by its prescience and apparent lack of uptake of key recommendations. Just two years prior to the publication of Nelder’s article, the American Psychological Society was contemplating banning the use of hypothesis testing in its journals (Shrout 1997). As noted by Shrout (1997), this was not the first time such calls had been made; he cited the infamous case of the *American Journal of Public Health* which advised authors that “all references to statistical hypothesis testing and statistical significance should be removed from the paper” and that you should “delete *p*-values as well as comments about statistical significance.” The journal *Epidemiology* adopted the same stance under the editorship of Ken Rothman. Rothman’s advice to would-be authors was blunt:

“you can also enhance your prospects if you omit tests of statistical significance . . . we do not publish them at all. Not only do we eschew publishing claims of the presence or absence of statistical significance, we discourage the use of this type of thinking in the data analysis, such as in the use of stepwise regression” (Rothman 1998).

The philosophical debates about null hypothesis significance testing (NHST) have been with us for many years and the attempts of a single misguided journal editor to deny the existence of a well-established mode of statistical inference were inevitably doomed from the beginning. While Nelder (1999) was equally strident in his criticism of sloppy statistical practice, his calls were not to ban *p*-values per se, but to demolish the *culture* of uncritical thinking that had developed around the routine application of hypothesis testing and the attendant practice of “asterisk hunting.”

So what went so terribly wrong whereby some of our scientific colleagues wanted to exorcise themselves of statistics? And indeed, where were the professional statisticians and our societies during these debates? I believe such instances of high levels of dissatisfaction with statistics and the issuing of ‘statistical fatwas’ are the result of guilt by association. It is not that the statistical methodology is flawed; it is the indiscriminate and inappropriate application in other disciplines that undermines the integrity of our science. This is not dissimilar to the renewed debate in ecotoxicology over the legitimacy of a phenomenon called *hormesis* (Kaiser 2003; Douglas 2008). Hormesis is the term used to describe the apparent beneficial response of an organism to very low concentrations of a toxicant. Examples relevant to humans include vitamins, alcohol, and fluoride. The decision to include or exclude test results showing hormesis in the fitting of a species sensitivity distribution (SSD) can profoundly alter the declared ‘safe’ concentration for that toxicant. While

hormesis is real and observable, it fell from favor in the 1980s as comparisons were drawn with homeopathy—a largely discredited alternative therapy (Wahlberg 2007) that claims medical efficacy through the administration of extremely low doses of preparations. In statistical science, I refer to the *statistical hormetic effect*—the discrediting of our profession due to the dilution of sound practice! So this brings us to the question of who has the right to call themselves a statistician?

3. ACCREDITATION

Apparently we are in short supply and always have been. More than a quarter of a century ago Minton informed us that “the demand for statisticians will far exceed the supply for the years 1978–1990” (Minton 1983). While in the middle of writing this article, the latest copy of AMSTAT NEWS arrived—Xiao-Li Meng and his “happy team” are featured. Meng’s article commences with a quote from Google’s Chief Economist, Hal Varian who predicts that the “sexiest” job over the next ten years will be that of a statistician (Meng 2009b). I hope he is right and that we can erase the parenthetical linking of statistics and misery from the title of Meng’s (2009b) article.

Meng (2009a, 2009b) noted the difficulty that most students have with our subject area and warned us that “we could screw up big time . . . if we do not offer enough good quality courses.” No issue here—I think we are all agreed that targeted, relevant, and stimulating courses in *statistical science* will be critical to our ability to thrive into the future—indeed, even to be seen as “sexy”! However, this internal debate about what to teach and, more importantly, by whom seems to have locked us into a perennial second of February (2/2)—our statistical Groundhog Day.

Kettenring’s claim that other disciplines had effectively been ripping us off (Kettenring 1996) echoed the more restrained assessments of Kish (1978), Minton (1983), Billard (1998), and a host of others. By 1990 the decline in University Statistics Departments had already commenced (Barabba 1990), further cementing the ‘in-house’ teaching of statistics in some institutions. On the related issues of appeal and difficulty, Duckworth and Stephenson (2002) gave us a ‘heads-up’ when they noted that “today’s courses in statistical methods, for the most part, focus on the same methods that were taught 30 years ago” and suggested that part of the reason we find ourselves stuck at 2/2 is our professional inertia and “natural conservatism in our academic departments.” It is thus refreshing to see Meng’s statistical group doing so well at Harvard.

Consensus on the issue of *who* should be teaching statistical science has been much slower in coming. While it is relatively easy to describe who we *do not* want, it is clearly more difficult to agree on minimum standards and competencies for persons deemed qualified (dare I say ‘certified’) to teach our subject. The issue of certification for the ASA has been on the table for a good 15 years or more and was comprehensively debated in the May 1994 issue of this journal. Recently the ASA Board of Directors endorsed a recommendation of the Individual Accreditation Proposal Review Group to begin a program of vol-

untary individual accreditation of (ASA) statisticians (Bock et al. 2009).¹ In announcing this decision (available at <http://www.amstat.org/news/VoluntaryAccreditationofStatisticians.cfm>), it was noted that it brings the ASA into line with its sister societies: the Royal Statistical Society (RSS); the Statistical Society of Canada (SSC); and the Statistical Society of Australia, Inc. (SSAI) in offering such a service to its members. Participation in the ASA's PStat. certification program is to be entirely voluntary with admission based on considerations of such things as: experience; competence; ethical standards; and communication skills. Although there is far from universal support for the Pstat. scheme, it must surely represent substantial progress to the establishment of minimum standards (over and above an academic degree) required to be formally recognized as a statistical educator/practitioner/researcher.

There is, however, one area of the PStat. process I believe requires strengthening and that concerns reaccreditation. As it currently stands, the initial accreditation will be for a period of five years after which time it *may* be renewed. The announcement on the ASA's website acknowledges that "there are many details to work out" and presumably the process of reaccreditation is one of those. In making its recommendation, the Individual Accreditation Proposal Review Group noted a variety of approaches to certification exist, citing examples in accounting, aviation, and project management. As both a private pilot and a chartered statistician (CStat.) I can attest to this. The validity of both my 'licenses' is indefinite but the similarity ends there. To remain a CStat. I need only pay an annual fee, whereas to retain my Private Pilot's License (PPL) I must undergo a comprehensive medical examination *and* demonstrate competency in the cockpit every two years. Furthermore, if I wish to fly a different *type* of aircraft or even the same type but at a different location, I will be required to undertake training and/or a flight check before being allowed out on my own. There are clear and obvious reasons for this and, while I am not suggesting the reaccreditation process for PStat. be as rigorous, I certainly believe there is merit in adopting an evidentiary-based review process.

4. QUO VADIS?

I think it is true that as a profession statisticians 'punch above their weight'—we are relatively small in number although our reach and influence has been, and continues to be, great. While the pace of breakthrough advances in statistical science may have slowed somewhat since the heady days of Gossett, Pearson, Fisher, Yates, and Neyman, the challenges facing our profession in the 21st century and beyond are no less daunting—albeit of a different nature. The preeminence of organizations such as Google which are gathering and linking massive and disparate datasets on spatial and temporal scales spanning orders of magnitude will demand new modes of analysis capable of rapidly teasing out *information* from terabytes of *data*. Likewise, the omnipotent threat of climate change and climate variability will sharpen the focus on the statistics of extremes. At the other end of the data continuum, our risk-based approach

to life will require credible and scientifically defensible assessments to be made of events yet-to-happen or which may never happen. Statistical modes of analysis for such data-poor environments will, I predict, become more common. Practitioners and researchers in the life sciences have discovered Bayes and are demanding more training courses in Bayesian statistics. The software engineers have been quick out of the starting blocks and have unleashed new generation software like Nettica (Norsys Software Corp.) and AgenaRisk (Agena Limited) for constructing and analyzing Bayesian Belief Networks (BBNs). I suspect that in some quarters, the enthusiasm for training in Bayesian statistics is less than the enthusiasm with which the software is being adopted and used. Such a situation sets us up for another fall as the Bayesian paradigm is pushed beyond its capabilities and/or is inappropriately applied.

I provide these examples to make the following points: (i) the future is ahead of us—not in the rear-vision mirror; (ii) the directions for statistical science will increasingly be determined by the (unprecedented) challenges facing society and mankind; and (iii) statistical training at undergraduate and postgraduate levels in all disciplines will need to be built on a traditional core but with stronger emphasis on robust, fit-for-purpose model and tool development in environments characterized by massive amounts of data; virtually no data; and extremeness.

In closing, I believe our profession has an incredibly bright future ahead of it and as Gnanadesikan (1990) observed, the core of our discipline is (still) in excellent health. The opportunities to make a difference in all walks of life abound. That is not to say we have been sitting on our hands for the last 100 years or more! Indeed quite the opposite. Careful planning, consideration of alternatives, and evaluation of our decisions will always be hallmarks of our profession and approach to science. The trick is to know when to draw a line under the introspection—to avoid the situation of 'paralysis by analysis' and to simply 'get it going' rather than 'get it perfect.' As the Individual Accreditation Proposal Review Group suggested to the ASA Board (Bock et al. 2009): "the time has come to make a decision—either launch a program, such as the one we are suggesting, or say definitely that this is not for us. It's time to move on!"

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¹ Since first preparing this article, the ASA has announced the formation of an accreditation committee.

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