

Statistics in Defense and National Security: Lessons in Outreach to Policymakers

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For this month's column, I'm pleased to have representatives from the ASA's Section on Statistics in Defense and National Security as guest authors. Members of this section have made outreach to policymakers an integral part of their activities, with significant strides. After attending, and being impressed by, their meeting during JSM this summer, I thought it would be helpful for them to share with other ASA members their progress to date and their plans for the future. ~ Steve Pierson, ASA Director of Science Policy, pierson@amstat.org

At JSM this summer, the Section on Statistics in Defense and National Security (SDNS) sponsored a one-day meeting that was attended by senior defense and homeland security officials. The meeting was one effort by SDNS to educate decisionmakers about how statistics and statisticians can address their challenges. It also helped educate our fellow statisticians about the many interesting and exciting opportunities in this area. We accepted the invitation to write this column to share our activities with you so you might learn from our experience, but also so we can hear and learn from you.

A brief history of the SDNS section is helpful to understand our efforts and illustrate the importance of persistent, incremental progress. Our inception can be traced, in part, to the 1984 JSM comments of former ASA President Richard Savage, who argued that statisticians should have a major role in defense issues because of the inherent uncertainty and the measurement of variability in so many of its topics. Through the support of many ASA presidents and committed ASA members, SDNS started as a committee in 1988 and became a section in 2004. Former ASA President Sallie Keller-McNulty was particularly helpful in assisting SDNS in identifying potential outreach directions through her establishment of the ASA Task Force on Defense and Security.

Keller-McNulty's comments from the time echo themes going back to Savage and lay out a clear challenge for the ASA:

National/international security is a problem that is growing in importance at a frightening pace, and my experience at Los Alamos National Laboratory has made me aware that statistical science is nearly invisible in this arena ... ASA must provide a strong and unified voice that

Science Policy Actions

- ASA president sends letter to Secretary of Education Arne Duncan regarding stature and autonomy of the National Center for Education Statistics
- ASA president joins leaders of 17 other science organizations in signing letter to all U.S. senators on scientific consensus of climate change science
- ASA president sends letter of support for Bureau of Justice Statistics director nominee, James P. Lynch
- ASA hosts meeting on election auditing attended by statisticians, election officials, political scientists, computer scientists, and voting advocates

will make statistics an integral member of the national and international security communities.

To answer this challenge, her task force developed a long set of recommendations, many of which are the basis for SDNS' road map. The map is rather broad, so we'll focus on the items most relevant to policy.

Outreach to Decisionmakers

The meeting held during JSM was planned to take advantage of JSM being in Washington, DC, and funded by a member initiative from the ASA Board of Directors. A day-long event, the morning sessions included presentations by senior officials of the Office of the Secretary of Defense, U.S. Army, Department of Homeland Security, Defense

Missile Reliability

During engineering design, you expect to find failure modes. For example, in a missile design, you might fire five missiles and see two failures—say an engine ignition or battery failure. The engineers then try to fix the failures. After the fixes are incorporated, how do you calculate the reliability?

To simplify, the original approach (using the Lloyd method) turns failures into successes if those failures don't occur again in the next few shots. The method is simple, direct, and easily calculated. It led to a reliability estimate of about 0.93 in our case. The raw score would be the result if the failures were not turned into success, but retained as failures. Both methods are, in some sense, wrong. Using the raw score fails to account for the effort (and possible success) to fix failure modes. Yet, the Lloyd method gives too much credit to the fix, because it does not recognize that observing one failure may prevent, or shadow, the possibility of seeing another.

What we have here is a system that has many failure modes, each with its own failure rate, and the failure rate of the whole system is a combination of all failure rates. When an engineer removes a failure mode, the combined failure rate will change. Common experience is that each failure mode follows a Poisson distribution. So, the growth in reliability is nonhomogeneous Poisson process (more complicated because the events are discrete). The method is not simple, not direct, and not easily calculated.

In this case, the absence of a statistician in the beginning allowed both the government and contractor to be fooled about the reliability of the system, illustrating our point that statisticians have an important role in helping the government determine how best to use the available data.

Advanced Research Projects Agency (DARPA), and Joint Warfare Analysis Center.

Nozer Singpurwalla of DARPA gave the keynote address. He focused on the historical roots of statistics in defense problems, applications of statistical approaches, and success stories.

Other presentations largely focused on the challenges the speaker's office/organization encountered and where they thought statistics might be able to play a role. They addressed issues such as how good they are at anticipating defense needs, whether the systems they produce are better than what is already available, and what is likely to be transforming.

One speaker noted that one of his biggest problems is the data—it is usually messy and often has missing observations. We also heard about the operational point of view in a talk by a representative of the Joint Forces Command. He gave us interesting information about the analytical challenges in the joint operating environment, how the forces will be fighting in the future, and how he sees statisticians contributing to the nation's security.

In the question-and-answer period that followed each presentation, participants asked questions and suggested ways statistics could help address the issues.

Most speakers had a basic understanding of statistics, but came away with a better appreciation for the role statistics can play. We tried to impress upon them the gap between the state of the art of statistics and what they may have picked up in a graduate statistics course 20–30 years ago. They learned about areas where their interests overlapped those of statisticians. Contact information was exchanged and follow-ups are occurring.

The afternoon session featured remarks by SDNS members on how statistics was already being used successfully on defense- and security-related problems. These presentations included work on biosurveillance, test and evaluation, and text data mining. Most presentations will be posted to the SDNS web site at www.amstat.org/sections/sdns.

Other activities members of SDNS have pursued in an attempt to reach out to decisionmakers include hosting meetings between ASA presidents and Department of Defense and CIA policy offices to raise the visibility of statistics. While the reception has been positive, it is important that this be an ongoing activity and that we also seek meetings with officials in the Department of Homeland Security and Department of Energy Office of Science.

We also have reached out to the Defense Science Board (DSB), partly through ASA leadership, and have been told that statisticians will be recommended to DSB study panels that require statistical expertise. We continue to push for a statistician to be appointed to DSB.

Outreach to Fellow Statisticians

Recognizing the importance of having more statisticians involved in national security projects to broaden our influence, we have undertaken many activities to educate the community about the many interesting problems and their potential for statisticians. In addition to inviting statisticians to this summer's meeting, we've been organizing JSM sessions that show the breadth of activity in defense and security—from cyber security to biosurveillance to more traditional areas such as reliability. We also

are organizing the third Quantitative Methods in Defense and National Security (QMDNS) conference, which was established to link defense problems to statistical solutions. Participants include both defense industry workers and statisticians. (See www.galaxy.gmu.edu/QMDNS2010.)

SDNS also established a speakers program (see Page 63 and www.amstat.org/sections/sdns/speakers.html), again with funding from an ASA member initiative, to provide speakers and travel funding to universities and colleges interested in hearing a presentation about statistical aspects of national security challenges. We have a dozen people on the speakers list and encourage you to both invite a speaker to your institution and add your name to the list.

Success Stories

While there is much more that statistics can contribute to this field, statisticians have made an impact on national security problems. One example is a major defense acquisition program that ran into reliability problems because of faulty methodology for tracking reliability improvement during development. It was a statistician who laid out the rules for estimating reliability, allowing the program to get back on track (see “Missile Reliability”). Other examples can be found at www.amstat.org/sections/sdns/SDNS_ThePresent.pdf and www.amstat.org/outreach/pdfs/StatSigNationalSecurity.pdf.

Next Steps and Lessons

Our next steps for outreach to policymakers are to continue and broaden our current activities by reaching more officials and statisticians and revisiting those we’ve already met. For outreach to statisticians, we hope our enthusiasm for the many interesting problems statistics can address in this field was manifest. We welcome your involvement and advice.

As our history indicates, this has been a long road, but we can point to real progress for statistics in national security issues. Clearly, much remains to be done. One lesson we’ve learned is that we need to do a better job of educating decisionmakers about what statisticians do. For those who realize the value of statistics, our experience is that sometimes the statistics is not always done by statisticians. So, we need to communicate more convincingly that statisticians can bring state-of-the-art techniques to a problem, which may yield better solutions faster.

For other sections exploring how to better reach policymakers, we highly recommend using the resources available from the ASA, especially funding through member initiatives. ■

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