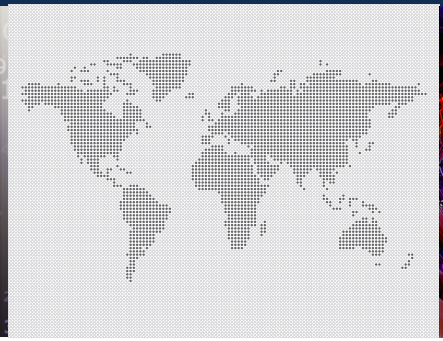
SAND2017-11063C

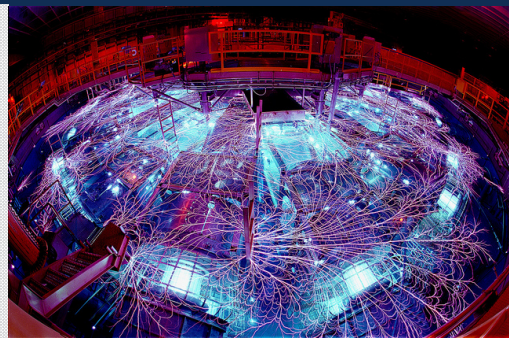
Exceptional service in the national interest

Sandia National Laboratories

SANDIA STATISTICAL SCIENCES

Plan. Analyze. Inform.





Practical challenges of statistical leadership for early-career statisticians

Lauren Hund

October 21, 2017

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Overview

Sandia National Laboratories

- Three aspects of early statistical leadership
  - Putting your stamp of approval on an analysis.
  - Picking your projects wisely.
  - Leading projects.

- What I'll be talking about:
  - Learning when and how to say 'no' is an important part of becoming a leader.
  - Navigating early career challenges to set yourself up for statistical leadership.

- Some themes:
  - Communication, confidence, and defining your role.

Experiences that have shaped my views

Sandia National Laboratories

- PhD in biostatistics at HSPH (5 years)
  - Collaborated on public health research (2 internships abroad), led my own research, teaching assistant.
  - Huge statistics presence, great infrastructure and ample resources for data science.

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

- Assistant professor at UNM medical school (2 years)
  - Collaborated on NIH-funded research projects, led my own research, taught MPH biostatistics courses.
  - Smaller statistics presence, less infrastructure and fewer resources for making data science happen.

UNM

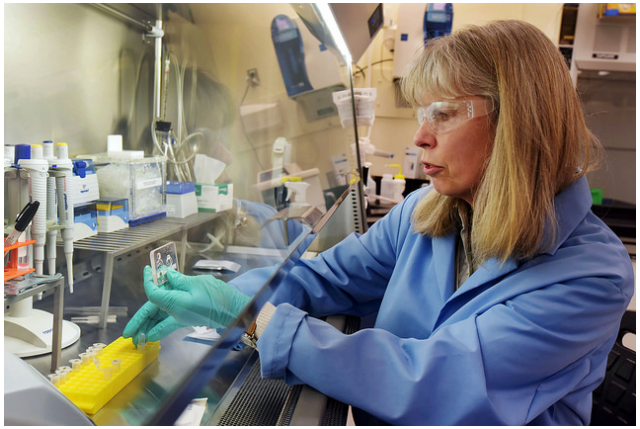
- Statistician at Sandia National Laboratories (3 years)
  - Collaborated with engineers and others, led my own research, taught internal Sandia courses.
  - Smaller statistics presence, less infrastructure but ample resources for data science.

Context and mentorship shaped my thinking about statistical leadership.

Leading as a female

- Working in a medical school and engineering lab has changed my perspective on gender issues.
  - Often the only female in the room.
  - Increased awareness, changed behaviors.

- Be aware of:
  - Implicit bias.
  - Saying yes too much.
  - Highlighting weaknesses over strength.
  - Excessive passivity.



Aspects of leadership

1. Putting your stamp of approval on an analysis.
2. Picking your projects wisely.
3. Leading projects.

Sandia National Laboratories

THE STATISTICS STAMP OF APPROVAL

The Statistics Stamp of Approval

- As a science of uncertainty, statistics plays an integral role in advancing science and improving decision-making.
- Collaborators and customers often aim to use statistics to:
  - Show evidence in support of a hypothesis.
  - Support a decision.
- Statisticians are often asked to provide a 'stamp of approval.'

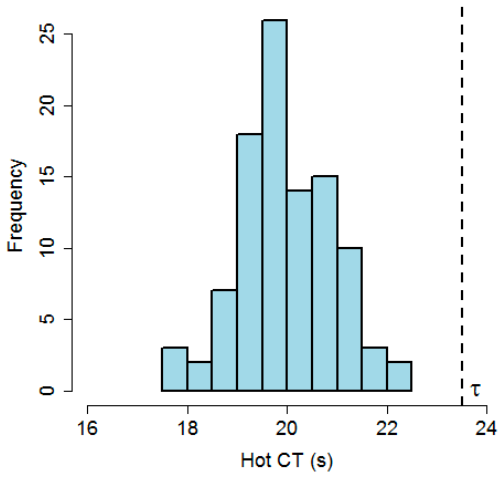
Activities:

- Collaborating or consulting on scientific papers or reports.
- Peer review of papers or reports.
- Proposal writing.
- Communicate risk or uncertainty to a stakeholder.

The Statistics Stamp of Approval

- There is often a need to **withhold approval**. Why?
  - Hypothesis cannot be tested from the data.
  - Statistical errors.
  - Not enough information.

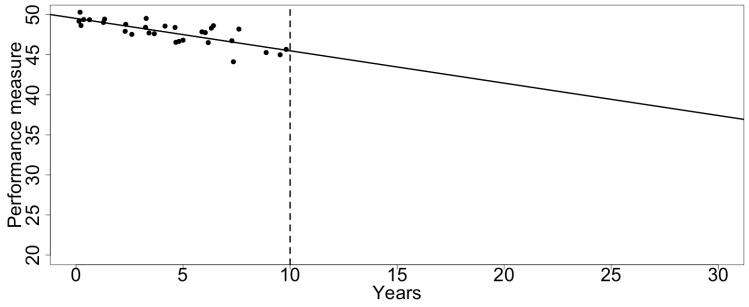
- **Examples of not enough data to test a hypothesis:**
  - **The pilot dilemma:** Small funding = small sample.
    - R21 grant awarded as a pilot; must publish for more funding.
  - **The engineer's dilemma**: High requirements, limited data.
    - "I need to demonstrate a requirement 99.5% of the time with 95% confidence at all of these different areas of the design space. Here's 20 samples."



Common statistical errors

- **Confusing statistical and practical significance:** "What is a statistically significant sample size?"
- **Extrapolation beyond the range of the data:** Predicted lifetime in reliability analyses without a physics model.
- **Accepting the null:** Conducted a health education intervention and accepted the null of no effect based on p-values alone.
- **Multiple testing/p-hacking/data dredging:** Conducted a survey in a unique physician study population. No well-defined hypothesis, so tested everything.

  Multiple ways to define an intervention variable. Tested all and picked the one that looked the best.



The ASA's opinion (Wasserstein and Lazar 2016)

1. P-values can indicate how incompatible the data are with a specified statistical model.
2. P-values do not measure the probability that the studied hypothesis is true, or the probability that the data were produced by random chance alone.
3. Scientific conclusions and business or policy decisions should not be based only on whether a p-value passes a specific threshold.
4. Proper inference requires full reporting and transparency.
5. A p-value, or statistical significance, does not measure the size of an effect or the importance of a result.
6. By itself, a p-value does not provide a good measure of evidence regarding a model or hypothesis.

Some solutions

- **Avoid complacency.**
  - Surprise, disappointment, acceptance, action.
  - Give thoughtful feedback - example: peer review.
- **Communication is often as important as technical skill.**
  - No jargon.
  - Give an alternative solution.
  - If you respond in writing, double check your work.
- **Educate.**
  - Teaching opportunities are prevalent and can lead to new opportunities.
- **Make sure your voice is heard.**
  - When reviewing papers, focus on the discussion – are all the limitations there?
  - Make sure your work gets incorporated – meet in person.
  - Follow-up.

Some solutions

- **Learn from the pros:** Read non-technical literature.
  - *Greenland 2017*: For and Against Methodologies: Some Perspectives on Recent Causal and Statistical Inference Debates
  - *Hahn and Meeker 1993*: Assumptions for statistical inference.
  - *Pidgeon and Fischoff 2011*: The role of social and decision sciences in communicating uncertain climate risks.
  - *Levine et. al 2008*: A critical assessment of null hypothesis significance testing in quantitative communication research.
  - *Gelman and Shalizi 2013*: Philosophy and the practice of Bayesian statistics

- **Advice from the experts (borrowed from colleagues):**
  - Don't wait to discuss co-authorship.
  - A little knowledge is a dangerous thing. Collaborators who know a little but think they know a lot are a problem.
  - Take time to develop expertise in the field where you are collaborating so you can judge whether a hypothesis is interesting and testable yourself.
  - Look for red flags in collaborative relationships.

The Statistics Stamp of Approval

- **Barriers to solutions:**
  - Aversion to negativity
    - No one wants you to make more work for them
    - No one wants to hear negative things about their work.
  - Belief in the **magic of statistics**.
  - Way too much jargon.

- **Choosing when to approve requires a lot of judgment.** Examples of advice from "acclaimed" statisticians:
  - Try to publish everything you do.
  - You're basically expected to have 100+ publications as a mid-career applied biostatistician.
  - Never put your name on anything you don't believe in.

Sandia National Laboratories

PICKING PROJECTS WISELY

Pick your projects wisely

Sandia National Laboratories

- Choosing projects where you will have the opportunity to lead as a statistician is critical to early career success.
  - Your ability to leverage your subject matter expertise impacts the rate at which you become a statistical leader.
  - Building productive collaborations is ideal.

Types of projects:
- ***Collaborating*** statistician on a long-term project.
- ***Consulting*** statistician on short term project.
- Committee member/service.
- Teaching.

Key questions: impact, role, time commitment, connections?

Bad projects reduce leadership potential

Sandia National Laboratories

- Lack of a need for your statistical expertise.
  - Examples: Making tables and scatter plots, running computer models.
- Poor project management.
  - Examples: Failure to stick to timelines, publish results, low visibility.
- Getting spread too thin.
  - Example: Inability to produce quality work because too many projects.
- Clashing personalities.

Saying no often requires uncomfortable confrontation.

Beyond technical contribution

- Leadership on projects often extends beyond contributing "technical" statistical work.
  - Spend time getting to know your subject matter.
- Example: Proposal writing role often goes further than power calculation.
  - Refining hypotheses. Are the proposed specific aims testable using the proposed data?
  - Peer review. Do you understand the proposal? (If you don't, the reviewer won't.)

Some solutions

Sandia National Laboratories

- **Get the details up front!**
  - Talk to multiple individuals familiar with the project.
  - Don't commit if you can't visualize what you would contribute.
  - Don't commit if the details don't add up.
- **Be assertive.**
  - Avoid the tendency to say 'yes' to everything early on.
  - Be cognizant of power differentials.
- **Know when to call it quits.**
  - Try to steer the project in a different direction first.
  - Define your criteria for when to quit, e.g. potential for impact. Example - leaving my first job.

Pick your projects wisely

Sandia National Laboratories

- **Choosing projects requires a lot of judgment.** Different people have different motives for assigning projects.

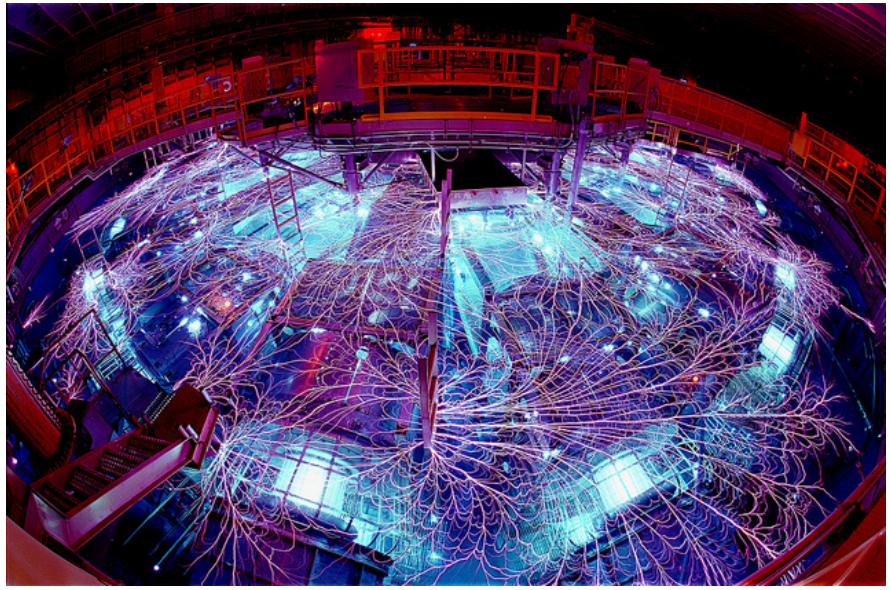
Mentor	Manager
Who you work with matters more than what you work on.	There's no such thing as a bad customer.
The only think worse than not getting a grant is getting a grant you don't want.	It's your responsibility to show your potential customer the added value of statistics (any money is good money).

Sandia National Laboratories

LEADING YOUR OWN PROJECTS

Leading projects

- Leading projects is obviously an easy way to lead as a statistician.
- My history:
  - NIH - 0/1
  - Sandia - 5/5 → Why?
- **Asking for money is an art.**
  - Tell a story.
  - Communicate impact.
  - Be confident.



How to generate project ideas

Sandia National Laboratories

- **What bugs you about current practice?** Can you do research to improve current practice?
  - New methods, new implementation, improved communication.
  - Example: Framework for integrating and communicating model uncertainty in quantifying margin and uncertainty for the nuclear weapon stockpile.
- **Consider impact.**
  - Interface with individuals who understand impact through seminars, networking, projects, consulting, mentoring, service, etc.
  - What do the people who control the money care about?
- **Know your strengths.**
  - And find other people to augment your weaknesses.
  - Example: Methods for calibration of computer models for estimating dynamic material properties.

Leading projects

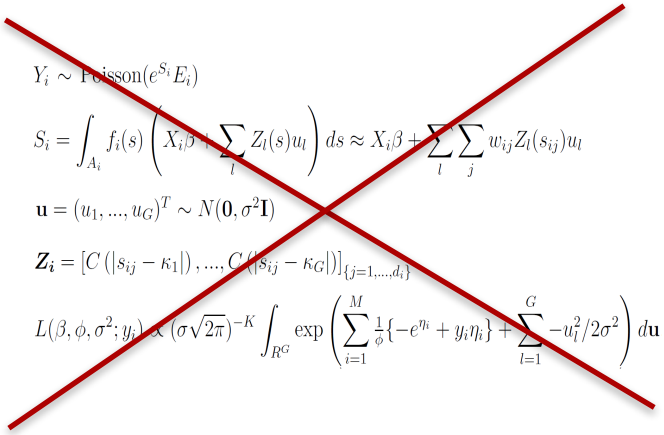
Sandia National Laboratories

- **How to get funding:**
  - Know your sponsor.
  - Follow the directions.
  - Think about impact.
- **How to use funding:**
  - Learn about project management.
  - Define and stick to a project plan.
  - Build and utilize a team.
  - Example: letting others pick your team.

Get experience with project management when you can.

Beyond BAMs

- Conveying (and having) impact is often more important than your mathematical prowess.
- Don't be a math bully or a victim of math bullying.
  - Leverage your place on the spectrum between the applied and theoretical.
  - KISS.
- Opportunities to lead may not look overtly statistical.
  - There is often value in statistical thinking.



Mentor advice:

- Spend time understanding the problem you are trying to solve before jumping to fancy statistical solutions.
- Most grant applications are thrown out because they don't address the call or follow the template.
- Need to learn how to sell your area of interest to non-statisticians.
- **Trust your intuition.**

Sandia National Laboratories

CONCLUSION

Conclusion

- Statistical leadership varies across different work environments.
- Early career leadership requires a lot of judgment calls that are easier with good mentorship.
  - Seek out more senior mentors.
  - Engage in peer to peer mentoring.
  - Stay in touch.
- Being confident, improving communication, and defining your role can go a long way.