Secrets of Successful NSF CAREER Proposals

Deborah A. Cook PhD

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A Synopsis of a Dissertation Entitled

Understanding the National Science Foundation's CAREER Proposal Genre: A Rhetorical, Ethnographic, and System Perspective

By

David M. Christensen

The Grant Science Lab

In 2011, David M. Christensen of Utah State University published a dissertation entitled, *Understanding the National Science Foundation's CAREER Proposal Genre: A Rhetorical, Ethnographic, and System Perspective.* Much of this dissertation is a research study of what makes a successful NSF CAREER proposal in terms of everything but the science. The author, using methods common to the humanities for document analysis, discusses what separates a funded proposal from the rest of the pile. This is a study of the structure, appearance, language, and NSF specific requirements of 20 proposals (12 funded and 8 unfunded) from across the NSF directorates submitted beginning in fiscal year 2004 through the Freedom of Information Act, the NSF CAREER website, and personal contacts. In some cases, the author had access to the principal investigators (PI), reviews, and panel summaries. Twenty proposals is far from a statistically significant sample size, but the analysis provides a snapshot of vital, cross disciplinary information common to successful NSF CAREER proposals that is applicable to other research proposals.

Admittedly, much of the rhetorical, genre, and other methods used in the analysis of these proposals is outside my expertise and probably yours too, but I focused on where the author had hard numbers. Even without hard numbers, one of the best parts of this dissertation is the interviews of 14 NSF program officers. Golden nuggets of great advice abound in their quotations and best practice recommendations. Some of this work points to a cultural analysis of the National Science Foundation, process of science, process of grant proposal funding, and us as scientists from someone outside the field. The take home lesson from this study, in my opinion, is that science is game and we are at play in our laboratories, offices, and field sites. **But you knew that already?**

The rules of this game are far too anecdotal. Realistically, the content reflects what I learned from experience as PI, a reviewer, panel member, and occasional grant writing workshop participant. All that learning is still anecdotal. To the best of my knowledge, the information in this dissertation remains unknown to the scientific community. A published work trumps anecdotal information anytime. Now that we know that peer review of proposals actually works (Li and Agha, 2015), it time to learn or relearn the rules of research proposal writing that allows peer review to make a difference.

Appearance

Overall proposal appearance doesn't matter in these days of electronic submissions and probably didn't matter when hard copy submissions were the norm. Appearance features common to 75% -100% of the funded proposals in the study included:

- 11 Point Font
- Italicized Key Words
- Page #s Bottom Centered
- Right Justified Margin
- Non-contrasting Heading Font
- Varied Heading Level Sizes.

Craftsmanship matters. Professionalism matters. The definition of these terms remains murky, but organization matters most. Organization matters most because it affects document design. Consistency of design along with proper grammar, punctuation, and spelling all contribute to appearance. A well-designed document guides the reader through the content with appropriate use of space, fonts, and graphics. Funded proposals used simple graphics with captions, directly referencing them as numbered figures in the text. NSF's Grant Proposal Guide is the rule book for appearance together with specific instructions in the CAREER Proposal Solicitation.

Organization

Appearance is only part of a CAREER Proposal's organization. Grant proposals have recommended if not required sections. Successful CAREER Proposals incorporated the following major sections in the project narrative:

- Introduction or Overview
- Substantive Preliminary Results
- Detailed Research Plan
- Broader Impact/Education Integration
- Results from Prior NSF Support.

Unfunded proposals failed to include problem statements, preliminary results, a clear research plan with goals and objectives, and results from prior NSF support. Funded proposals expanded the introduction into subsections covering project motivation and foreshadowing of intellectual merit and broader impact. Successful proposals had detailed research plans with subsections beyond the introduction covering goals, challenges, research methods, and a timeline. Moreover, unfunded proposals did not adequately address broader impacts or have solid education integration plans. Detailed Broader Impacts and Education Integration sections are characteristics of funded proposals in the pool. Broader Impacts and the Educational Integration Plans are requirements of all NSF proposals since publication of the dissertation. Hence they deserve their own section.

Broader Impacts and Education Integration

In general, funded proposals (92%) possessed strong plans of dissemination through scientific papers, conferences, websites, and other methods. Collaboration with industry or demonstrating a relationship to industry was a characteristic of 58% of the funded proposals. Unfunded proposals emphasized dissemination through textbooks or curricula. Integrated coursework, undergraduate research involvement, and inclusion of women and underrepresented groups were all features of funded proposals. Moreover, funded proposals employed an average of 4 educational strategies in contrast to 3 in the unfunded group. In addition to the three significant educational strategies listed above other types included:

- Workshops/Tutorials
- Online Collaboration
- Mentoring
- Evaluation Plans
- Campus/Community Service
- Outreach

Intellectual Merit

Intellectual merit is the other main review criterion of NSF proposals. With such a wide scientific variety of proposals in the study pool, the author as a non-scientist, relied on relied on reviewer's comments to address the relative intellectual

merit of both groups. However, most of these reviews came from the unfunded proposals. Clues to intellectual merit abound in NSF's own documents. They include understanding of the PI's scientific community, the expectation of novel, creative, if not risky scientific research that integrates educational plans, and includes women and underrepresented groups. Problems common to unfunded proposals were lack of preliminary data, timelines, and evaluation methods. Lack of preliminary data is also problem with proposals deemed too risky.

The old saying **"the devil is in the details"** holds true for the unfunded group. Lack of detail is the main theme of reviewers regarding these documents. Comments include:

- *insufficient technical detail to allow… a clear idea of possible outcomes*
- *proposal methods not adequately described*
- *details remain grossly underdeveloped throughout*

A secondary theme is that unfunded proposals have issues with the novelty and creativity of the proposed research. Reviewers commented that such proposals lack vision, would not advance the field, are too narrow, and lack innovative developments. Writers of funded proposals consistently used phrases or synonyms for novelty and research exigency. Examples of words or phrases associated with novelty or exigency include:

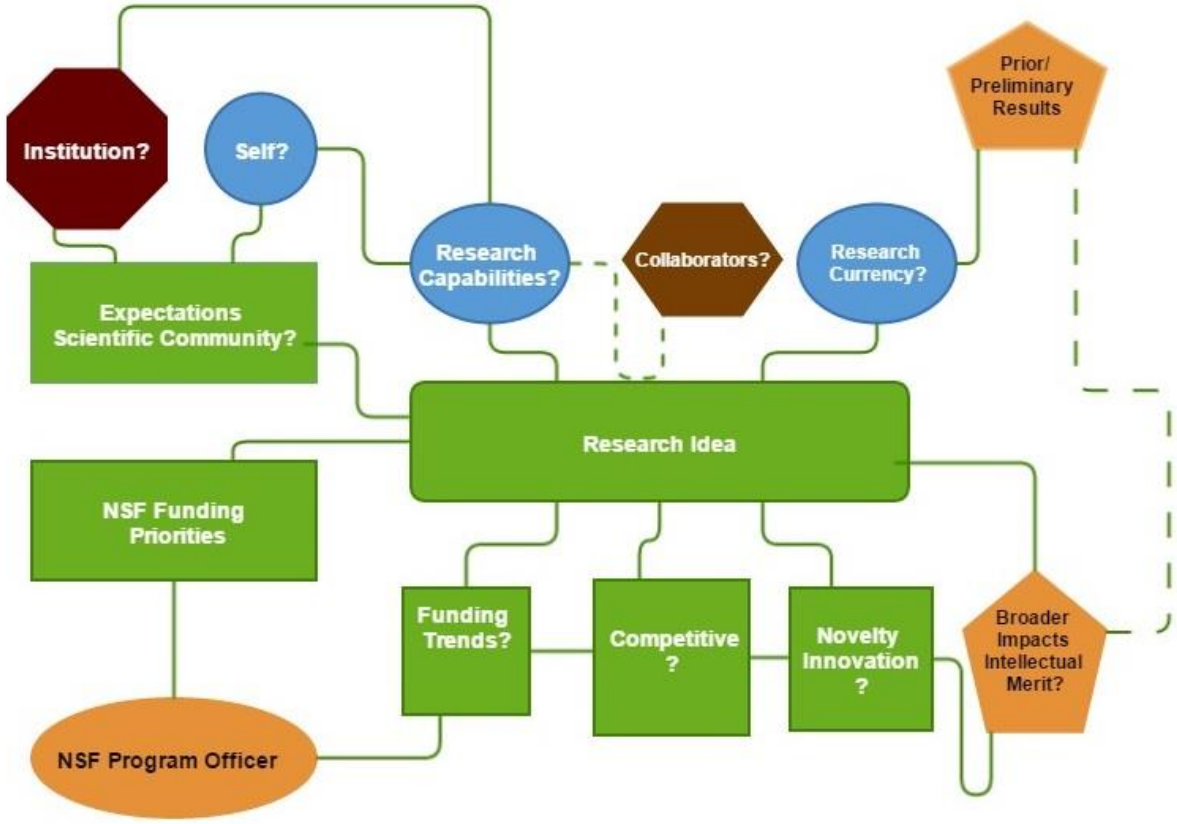
- *next generation*
- *emerging area*
- *relatively little is known*
- *presents many opportunities*

Therefore, a funded proposal hits a sweet spot of novel research, creative science, and the right amount of detail.

Proposal Homework

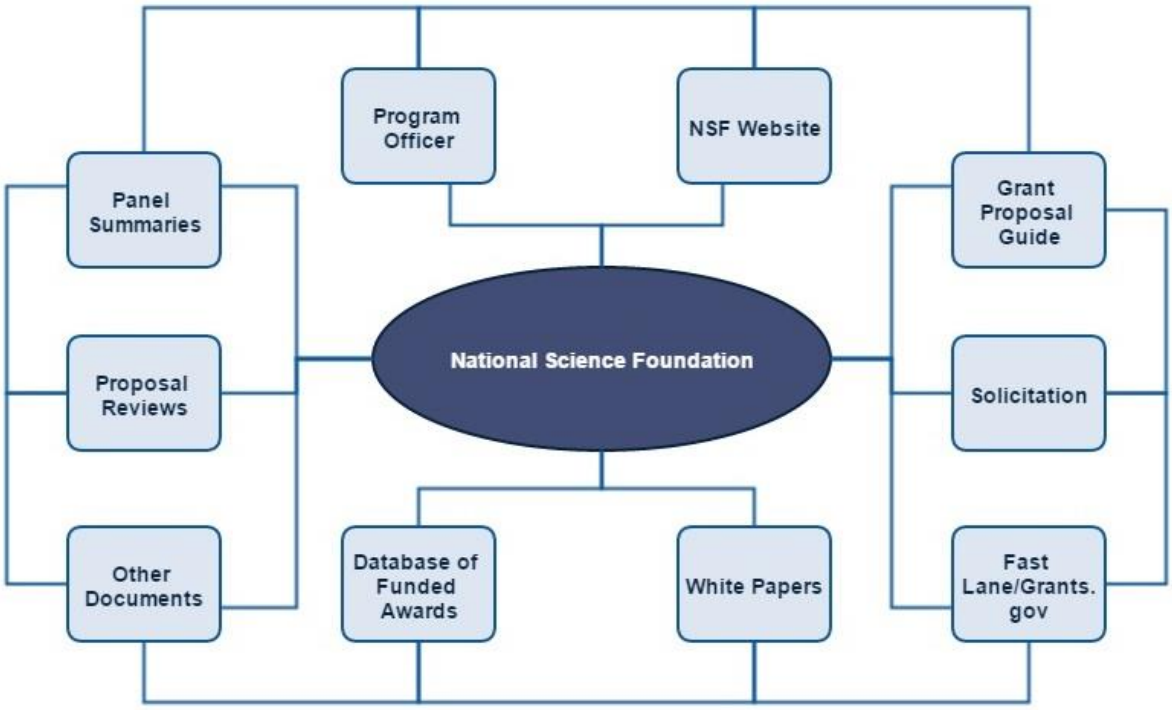
The foundation for a funded CAREER Proposal and by extension any other research proposal is homework. Christiansen spends an entire chapter discussing the NSF proposal process as a field of play with genre-agents and player-agents, but I think it boils down to **"do your homework before you write the first sentence."** Research proposals have many homework assignments beyond the scientific

literature and preliminary results behind a new research idea. These assignments don't fit into a neat list; rather they form a concept map with a research idea at the center. The following diagram is my interpretation of Christiansen's ideas and interactions around play theory of the NSF proposal process.



These homework assignments are questions that need answers and relationships that require clarity. Some are resources. Most of the relationships involve influential people. NSF program officers are among those influential persons. Contact them early and frequently in the proposal development process. Taken together these questions, relationships, resources, and answers form the **"rules"** of the game. It's a lot to take in before you even start writing.

Likewise, the general relationships of information sources within NSF are shown in the next concept map.



Technically, the database of funded awards is part of the NSF website, but it is a source of information on funding trends. Documents such as the Grant Proposal Guide, the Solicitation, and FastLane/Grants.gov are all about following directions in the application. NSF produces reports and white papers on topics such as the STEM workforce development that could be useful. Presentations from program officers on NSF proposal preparation are found in such places as Slide Share, YouTube, and more.

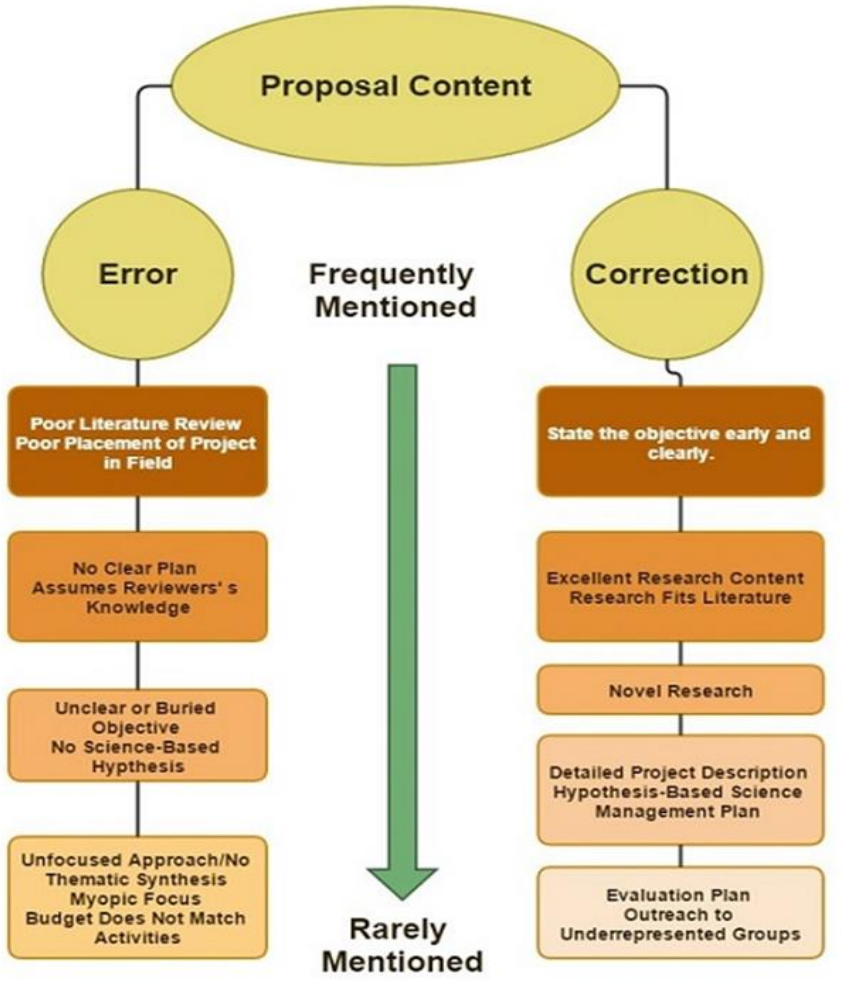
All of this is a lot of homework. It's a pithy phrase, but this is one of those places where **"Prior Preparation Prevents Piss Poor Performance"** really applies. Many grant writing workshops focus on following the directions. The hard part is the writing of a compelling proposal that engages the reviewer from the start. Those proposals get funded. This is where people need the most help and where best practices and advice from program officers is most useful.

Best Practices and Common Mistakes

Information from interviews of 14 program officers (5 women & 9 men) from across 6 directorates, 12 divisions, and 1 cross-cutting program contributed to a thorough collection of common mistakes, best practices, recommendations, and

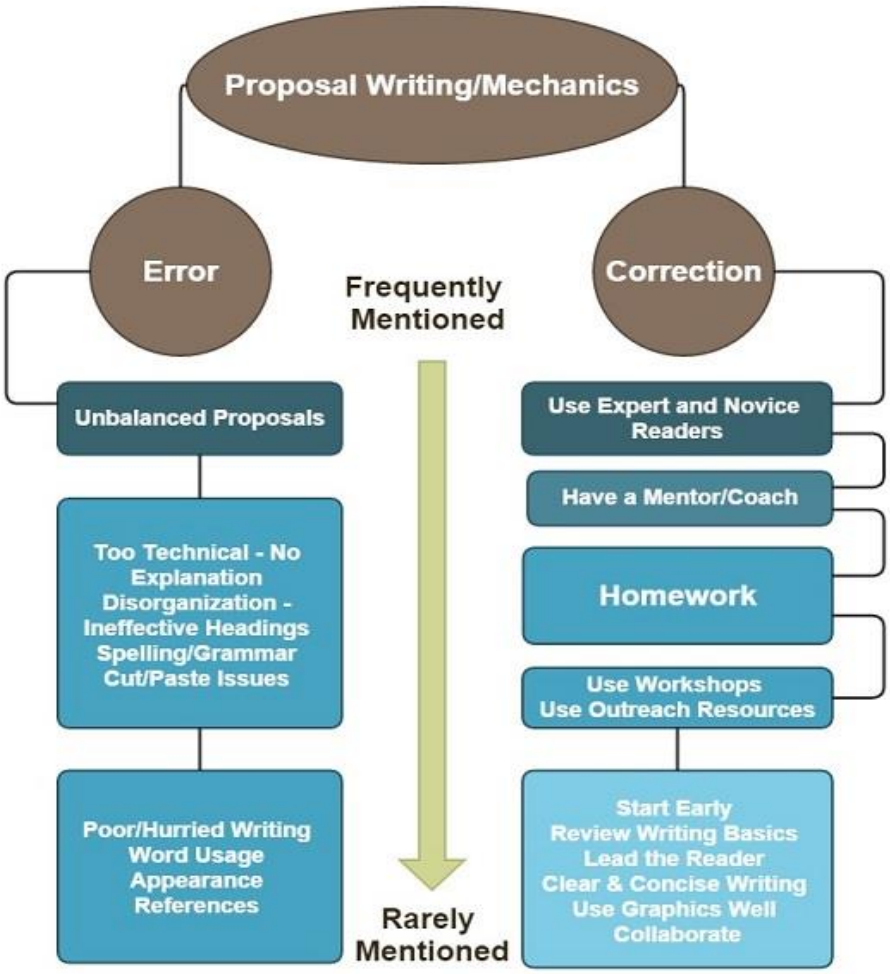
insights into the characteristics of a competitive proposal. First among their best practices recommendations comes as no surprise: **Follow the guidelines in NSF Grant Proposal Guide and other documents in preparing your grant application.** Their second major recommendation is also not surprisingly: **Do your homework as to what NSF program best matches your research.** Most common mistakes and their countering best practices are either mistakes of content or writing.

A clearly written proposal has few problems with content or writing. The following diagram, modified from Christiansen's dissertation explains content mistakes and their corrective measures from program officers.



Overall, a well-written proposal stands a better chance of funding when compared to poorly written proposals of equal scientific merit. Program officers mentioned communicating excitement, **"It's about being a good scientist and making your science interesting to some else."** Comments like this one speak to content and good writing.

Most writing mistakes can be avoided by doing much of the preparatory homework discussed above about knowing the rules of the game. Yet, the interviews provide even more worthy advice about writing. Good writing needs maturation. One program officer made that connection food, **"Like pasta, it's always better if you eat it the next day because the sauce."** Good cooking takes practice. So does good writing. Likewise, with content errors, common writing errors and the best practices to avoid them are summarized in the diagram adapted from the dissertation.



Poor writing is one of those things you'll know when you read it. It's not crisp, clear, and concise. Sadly, there are no examples of poor writing in the dissertation, but poor writing goes along with poor organization. Poor writing is not confident writing. A poor proposal is full of hidden ideas and hedged bets.

Unbalanced proposals have too much information in one section and not enough in others. Homework or prewriting work covers much of the previous information, but includes such advice as serving on review panels, gleaning information from prior reviews, and anticipating the reviewers' questions and concerns. There is no better way to learn how to distinguish the excellent proposal from the merely very good than serving on a panel. The reviews of a rejected proposal provide valuable information, but give yourself time and distance from them and your proposal before you tackle it again. Perspective matters. Anticipating the reviewer's questions and concerns helps to avoid rejection, but you can't read their minds, but this is about your knowledge. Back in the dark ages of the 1970s when I was in high school, my honors English teacher advised us to **"out guess the professor"** when it came to essay examinations. In a grant proposal this means knowing where the weak spots are and how to strengthen them.

Program officers have no sympathy for proposals based in unrealistic dreams, the reputation of the scientifically famous, shopping lists, or small fonts. NSF may allow 10 point fonts, but they are not friendly for ageing eyeballs. NSF doesn't cut any slack for non-native speakers of English either. As flawed as the spelling, review, and grammar tools might be in your favorite word processing program, they do work, but proofread and have a novice read your proposal draft. If a novice reader or non-expert scientist can't understand your proposal, then you have a problem.

Conclusion

When I think in hindsight about my funded awards over a 20 year career, those are the times I got it right. The times I got it wrong (there were many) involved scale, the state of current research, and were less hypothesis driven than I want to admit. The proposals recommended for funding from my panel experiences, expressed high levels of craftsmanship that involved ideas (scientific, educational, or other), organization, and writing. Good craftsmanship like good grantsmanship takes time and practice. The "Magic Bullet" for writing research grants that result in funding is a myth. Take time to develop your ideas, take time to organize matters, take time to get help, take time to write the words.

Christensen, David M., "Understanding the National Science Foundation's CAREER Award Proposal Genre: A Rhetorical, Ethnographic, and System Perspective" (2011). *All Graduate Theses and Dissertations.* Paper 923.
http://digitalcommons.usu.edu/etd/923

Li, D. and L. Agha (2015) Big names or big ideas: Do peer-review panels select the best science proposals? Science 348 (6233): 434-438.

http://www.sciencemag.org/content/348/6233/434.abstract?sid=7766a4e5-162c-48c5-86b5-0b7af117fabe