Advice for applying for graduate science fellowships: NSF, NDSEG, Hertz

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Summary:
The graduate research fellowship application process is best viewed as a highly competitive contest. To maximize the chances of winning, one needs to not only be technically qualified but also understand the motivations of the contest organizers and what non-technical traits they like to see in contestants. Anyone who hopes to win should seek the advice and guidance of those who have won in the past.

Introduction

These are the 3 fellowships available for U.S. citizens and permanent residents attending graduate school in a science major:

- National Science Foundation Graduate Research Fellowship Program - Called *'The NSF'*
- National Defense Science and Engineering Graduate Fellowship - Called *'The NDSEG'*
- The Hertz Foundation Graduate Fellowship - Called *'The Hertz'*

I have sorted these 3 fellowships in increasing order of selectivity (which is, unsurprisingly, also the increasing order of monetary compensation and perceived prestige). There are about 1,000 NSF awards given each year, about 200 NDSEG awards, and only 15 Hertz awards (the Hertz fellows are all super studs and studettes).

I applied for all 3 fellowships during the 2005-2006 academic year at the same time that I was applying to Ph.D. programs in Computer Science. I received the NSF and NDSEG fellowships, but was rejected by the Hertz, although I did get to experience a fun but slightly masochistic first-round Hertz interview.

This article contains advice that I have collected from my own experiences as well as those of friends and mentors who have received these fellowships. Nowadays the competition for these fellowships is so fierce that it is necessary but not sufficient to simply have superb technical qualifications; having good advice can mean the difference between a win and a near-win. I know technical geniuses who have been denied these fellowships because they refused to take advice from others and thought that they could win by simply laundry-listing their pure credentials.

Let me begin with my first and most general piece of advice: **Ask as many (relevant) people as you can about these fellowships, especially those who have won them, in order to get as many sample points as possible. Gather as**

much information and feedback as possible before submitting your application to give yourself the best possible shot. Don't just depend on your gut intuition.

Who should apply?

You should apply if you are simultaneously applying for a Ph.D. program in a science major (look at the individual fellowships for their particular definition of what constitutes 'science') or if you are in your 1st year of a Ph.D. program. All the fellows I know are (or were) Ph.D. students; it may be possible to get these fellowships to fund your Master's program, but I don't know anyone who's done so.

Why should you apply?

(1) Money, (2) freedom, (3) prestige, (4) practice, and (5) because your research advisor will make you apply anyways.

- **Money** - If you win, your tuition will be paid for and you will receive a slightly larger stipend than your peers who are receiving the standard university stipend. You will have a few hundred more bucks every month to either save away or to spend on bling bling for your office/2nd home.
- **Freedom** - You might have a bit more freedom in choosing advisors and research topics because your advisor doesn't have to make as large of a financial investment in you. He/she simply needs to provide guidance, not guidance and funding. You might not have to be restricted only to projects that a particular grant is specified to fund. Also, you might not have to TA as frequently.
- **Prestige** - Fellowships look good on resumes and CVs, just as marks of distinction. I don't know how important this is to you, but it's a nice free bonus that can't hurt.
- **Practice** - Even if you don't win a fellowship, the process of applying is great practice for graduate school applications. Fellowship deadlines are usually a month or so earlier than grad school deadlines, so applying for fellowships will force you to start preparing earlier and allow you to better organize and refine what you want to present in your grad school apps.
- **Your research advisor will make you apply** - When you are applying to graduate school, if for some bizarre reason you don't decide to also apply for fellowships, then in the following year (the 1st year of your Ph.D. program), your research advisor will most likely strongly encourage ('force') you to apply. Advisors always love for their students to get external funding, because it relieves pressures on their own accounts, so they will usually make their students apply for fellowships. If you already have a fellowship, then you don't need to go through this inevitable process, and if you don't win the first time around, you already have the experience so the second time should be much easier.

Can I benefit from the advice in this article?

Yes, only if you already feel confident that you are extremely technically qualified to win these fellowships. None of this advice can boost your credentials, so if you don't already have impressive credentials, then your chances of winning are pretty slim. So

what are the necessary credentials? Most of it is based on research. You must have participated in at least 2 or 3 research projects during your undergraduate years, made some noticeable contributions such as engineering research tools, completing successful experiments, and ideally, publishing results in peer-reviewed papers. Secondary qualifications include grades, GRE scores, and extracurricular activities involving science or leadership; but by far, the primary qualification is the caliber of your research.

How should I read through this enormous mess of an article?

Read this article in its entirety all in one sitting! Well, do that only if you want your eyes to crust up and fall out. This entire article is a brain dump of whatever I remember from my application process, with little attempt at editing, so it is anything but concise. Here is an abridged road map:

- o General Advice - Relevant for all fellowship apps
  - o The Game: Completeness, Clarity, and Coherence - The culmination of all my general advice
- o Advice for the NSF Fellowship
  - o Broader Impacts - An important but often overlooked part of the NSF application
- o Advice for the NDSEG Fellowship
- o Advice for the Hertz Fellowship

General Advice (my brain just took a huge dump)

Timeline

When I applied in Fall 2005, the Hertz application was due in late October, the NSF in early November (both before grad school apps), and the NDSEG in early January 2006 (after most grad school apps). I began getting organized in early September, at the beginning of the academic year. At that time, I sent out emails to professors whom I wanted to write letters of reference for me in order to secure the 3 letters required for NSF/NDSEG and the 4 required for Hertz. I also started my online applications, read through as much info from the official websites as possible, and took some notes to record down my first impressions of these fellowships.

If you start school in early September, you have approximately 8 weeks before the NSF and Hertz are due. After finishing those, you can take a breather for a while and work on the NDSEG over winter break, because that application should be quite easy after you've finished the NSF and Hertz.

This is obvious, but **don't procrastinate!** You will need a lot of time to revise your essays, taking people's advice into account. Don't simply think that you can wing it all at the last minute.

The differences between fellowship and graduate school applications

You will most likely be applying for fellowships at the same time that you are applying for Ph.D. programs. Although the two types of applications are similar in many ways, I recall one fundamental way in which they differ: The fellowship application process is more like a **contest** (with wins and losses), while the graduate school application process is more like a **job hunt** (with acceptances and rejections).

A grad school app is a job application for the job of a **research assistant**; the only thing the admissions committee really cares about is your potential for performing good research for their school. You should not take these applications lightly because rejection from graduate school means that you must alter your professional goals in life. One application tip I have heard repeatedly is that it is a good idea to try to broaden your appeal so that you are not pigeonholed into one narrow sub-field, thus running the risk of rejection if the few professors in that sub-field aren't interested in new students at the moment. (I've heard stories of students being rejected by a school because they adamantly proclaimed on their applications that they would only be willing to work with one or two specific professors, and those professors just weren't taking new students at the time.) For my grad school apps, I focused on one primary research interest, but also presented the breadth of my experiences and my openness and curiosity in trying 2 other related areas of research. I have heard that writing down **broader** interests helps you in grad school apps because you can appeal to more professors. However, don't stretch yourself too thin and say *'Oh, I love EVERYTHING in this field, including this and that and the other things'*. Aim for targeting at most 5 or 6 professors whose research genuinely interest you, and present evidence of how you became interested in their work.

In contrast, a fellowship application is a contest, and should be viewed as one. Give it your best shot, and it's no big deal if you don't win. You won't need to alter your life goals; you can still earn a Ph.D., receiving funding from a combination of research and teaching assistantships. In general, the fellowship app reviewers are looking for **focus and depth** in research interests over **openness and breadth**, which is in stark contrast to grad school application reviewers. They are not trying to find a place for you within a university research lab (where your presentation of breadth makes you a more flexible candidate); they simply want to see how well you can present yourself technically, so trying to describe too many different interests will dilute the persuasive force of your application. That said, you should still briefly mention the breadth of your research and extracurricular experiences (because those can't hurt), but make sure to **find one area in which you are intensely passionate about and focus hard on it**. You want to sound highly confident of your passion, interest, and ability to perform research on one particular topic, even if that is not going to be the topic you will eventually do your dissertation on. It's okay to win a fellowship and then completely drop the topic you wrote about in your essays; the fellowship reviewers know that many students will change their interests once they get into a Ph.D. program, but what they value is the fact that you can discuss a sophisticated technical topic clearly, eloquently, and with some personal passion. The most common topic that people choose to focus on is the research project they are currently involved in at the time of their applications. This is a great idea because of the writing principle of **show, don't tell** --- you want to show how you are interested in some topic by describing actual work you have done, challenges you have faced and overcome, lessons you have learned, etc., rather than simply tell the reviewers that you have a passion for something.

In sum, remember the following general rule: For grad school applications, try to present yourself with broader interests, and for fellowship applications, tighten your focus intensely and only mention your other interests in passing.

Logistics (getting organized)

When you begin the application process, make a note of every single item that you eventually need to submit (e.g., GRE scores, reference letters, online applications, etc.) and the deadlines for each item. After each item has been submitted, make a note of it along with the date, so that by the final deadline, you should clearly see that all items have been submitted. I wrote all of this info in plaintext files, but some people prefer to use a calendar application. Whatever you use, just make sure you write down these logistical points ON THE COMPUTER (and not just on flimsy post-in notes). Being organized will prevent you from making stupid mistakes like missing a deadline and disqualifying yourself from competition.

Also, make a directory on your computer dedicated to fellowship applications, and a sub-directory for each fellowship. Write down advice that you collect in text files within the appropriate sub-directories. Don't think that you'll remember everything when crunch time comes; just be safe and write it all down. Although you can save partially-completed applications online, it's pretty dumb to simply use the web form text boxes as a word processor (there's no spell checking). Write your essays offline and save and backup your files neurotically like there's no tomorrow!

Area of specialty

All the fellowship apps ask you to either choose or to write in an area of specialty within your major (for Computer Science, areas might include 'robotics', 'software engineering', 'theory', etc.). I feel that this choice is very important, because it will determine who will read your application. It also places you into a particular applicant pool with other competitors who are writing about the same interests. Choose a specialty that you feel you can write about convincingly and with solid evidence of research in that specialty, because that will maximize your chances of winning. Don't try to game the system by choosing some obscure area you feel that there isn't much competition in --- choose the area that you can most convincingly portray with evidence of personal passion and research in your application.

Letters of reference

In order to have a competitive application, you will need 1 super good letter, 2 pretty good letters, and 1 alright letter (this 4th letter will only be used by Hertz). The 1 super good letter should come from your current research advisor and provide additional evidence to bolster your primary focus point about how you have a ton of passion for work in your particular area of specialty. The 2 pretty good letters could come from professors whom you have previously done research for, even if you simply did low-level grunt work, or research scientists at a lab you interned in. Unless you have no other choice, don't get a letter from a professor who taught a class that you got a good grade in, because reviewers give very little weight to these 'did well in class' letters. The NSF and NDSEG only require 3 letters, so you are set if you can get 1 super good and 2 pretty good letters. The Hertz requires an extra letter, but I doubt that most students have done research for 4 different professors as undergrads, so

it's okay if this last letter comes from a company supervisor, 'did well in class' professor, or whatever, just because it's unreasonable for the reviewers to expect 4 serious research-based reference letters.

After you find your letter writers, spend some time preparing a printed informational packet to hand to them. This packet should include a brief resume, a small blurb of what strengths you want to focus on in your application, and, most importantly, a **summary of the work you have done for this particular professor, including notable achievements and results**. Having this summary on-hand will help refresh their memory and allow them to write a stronger letter for you, backed by solid evidence of your achievements. As the months roll by and the deadlines approach, send polite reminders every few weeks or so to make sure that they remember to write your letter, and offer to provide any additional information they might need. Don't go overboard and sound too demanding or pushy, though, because professors are very busy people. Oh yeah, after they have submitted all of your letters, make sure to show your appreciation by giving them thank-you cards. Sure, it's just a gesture, but it is a sincere one because they put forth effort to help advance your career, so you should be grateful.

How technical should the essays be?

The reviewers of your application will be researchers in your field, and probably in your area of specialty or in a closely-related area. Thus, write for a technical audience who is somewhat familiar with your area of specialty. It's still a good idea to not just pollute your essays with abstruse jargon, though. Spend some sentences relating your own research to the *bigger picture*; start with something that laymen can *almost* understand in order to provide context, and then drill down into the hairy technical details. Don't spend too much text being fluffy, though, because you want your essays to be concise and meaty. *Show, don't tell*. Show that you are good at doing X or that you are passionate about Y by citing evidence from your work or extracurricular activities. Also, whenever appropriate, provide citations of relevant journal or conference papers to show that you have an understanding of the literature (but don't go overboard and cite papers just for the sake of doing so, because that will appear overly contrived).

The importance of impact

Impact goes a long way in making a strong application. Don't just talk about what you tried to do in your research; rather, talk about what you succeeded in doing and how that impacted the world (albeit probably in some small way). Most likely, you aren't doing research that singlehandedly cures world hunger, but talk about any impact that your research has had, however small, such as enabling other researchers to make more progress (contributing to the research community), allowing students to learn better in the classroom (building educational tools), etc. Reviewers want to see not only that you've put yourself out there and tried to dive into graduate-level research as an undergrad, but more importantly, that you've persevered and been able to create, innovate, improve, etc. something that has some visible impact.

Another reason why the reviewers really look for evidence of impact is that they want to see whether you understand the meaning of research impact. An applicant who

understands what it means for research to have impact will more likely successfully pursue research with actual impact in the future. And the best way to demonstrate your understanding of impact (aside from an in-person interview) is to eloquently write about the impact of your research experiences.

The Game: Completeness, Clarity, and Coherence

To win the game of the graduate science fellowships, you need the 3 C's (indulge my corniness, please): Completeness (including every relevant technical detail in your application in some form), Clarity (presenting the best aspects of yourself clearly and concisely), and Coherence (having parts of your application tie into each other instead of being a disparate brain dump of facts ... unlike this article).

Most of your competitors will be technically qualified in science research, probably just as qualified as you or, more likely, even more qualified. The only thing that can set you apart is the *overall quality of your application*. If a reviewer had to choose between applications from two applicants with nearly identical credentials, I would bet that he/she would more likely choose to endorse the one that's better written, more logically organized, easier to read, and more memorable ... the one that best exhibits the 3 C's ...

- **Completeness**: Read through the application questions and essay prompts, then do a brain dump and jot down notes (on the computer) of all the things that you could possibly include in your applications, such as:
    - **Education** - Your school, classes taken, GPA, GRE scores, and other boring logistical stuff
    - **Academic honors** - Boring lists of awards, prizes, honor societies, scholarships, etc.
    - **Research experience** - Descriptions of what research you did, who you worked for, what you learned, what you accomplished, and what impact your work had. Remember, discuss your *impacts*, not merely your attempts.
    - **Work experience** - Descriptions of internships, teaching assistant gigs, laboratory assistant gigs, and any work you did during college that is not related to research. What did you do? What lessons did you learn? How did the experiences motivate you to want to pursue a Ph.D.?
    - **Publications** - Many undergrads do not yet have publications in peer-reviewed venues (I didn't when I applied), so it's okay if you don't either. If possible, though, you want the reviewers to not see a big awkward blank in the *Publications* section of your application. Thus, even if you published in a student journal or magazine, just write that down because something is better than nothing. If you submitted a paper for publication, write that down and say *Submitted for publication*. Try to write *something* rather than leaving that section blank.
    - **Intended area of research** - What research do you want to focus on in graduate school? Again, you are not legally bound to do this particular line of research, but you need to write about something that you can discuss competently (with mention of your previous research and literature citations) so that you can give the reviewers a sense that you are mature technically.

- o **Extracurriculars** - Only write down a select few activities that demonstrate evidence of *leadership*, *teamwork*, *intellectual curiosity*, *diversity in science*, or other key qualities that the reviewers are looking for (see the fellowship websites for listings of what traits they value). This isn't your undergrad application, so you won't impress reviewers with your laundry list of super-duper-cool high school clubs and volunteer activities; make sure that you list extracurriculars that strengthen your application instead of watering it down by diverting attention away from your research.
- o **Minority card (optional)** - This one isn't for everybody, but if you are an underrepresented minority or a woman pursuing a science Ph.D., or if you have extenuating circumstances, you might be able to play the minority card to your advantage. Don't be ashamed to sparingly mentioning your minority status throughout your application in tasteful places. This is a game, and everyone needs to do his/her best (within legal and ethical means) to try to win. It is really great if you are involved in clubs or professional organizations for minorities or women in science (especially as a leader), because that shows you played an active role in something related to promoting diversity in science. The NSF seems to be the most devoted to diversity, but read all the fellowship websites for the philosophy of each one regarding this issue. As an Asian-American male in Computer Science, I wasn't able to play this card at all (white males predominate my field at the Ph.D. level, but Asian-American males are the second most numerous), but I do know others who have done it well.

Spend some time revising and honing this brain dump, which should be written down in text files, and make sure that it meshes well with the blurbs that you handed to your letter writers. Remember, the 2 sources of information the reviewers will have about you are your own writing and the writings of your letter writers. You want the facts to corroborate and reinforce each other. When it comes time to actually fill out your applications, try to incorporate all of the brain dump contents into them in the appropriate places.

- o **Clarity**: Write in simple, direct, clear language, using technical jargon only when appropriate. Don't ramble like I do at times in this article, and absolutely don't make any risque remarks or jokes. **Your application submission should not be a brain dump.** If this article is awkward to read at certain places, that's because I just basically wrote whatever my brain was thinking. I took the actual writing in my applications very, very seriously, from the essays all the way down to the short answers and even to how I filled in the mundane details. You want your writing to appear as polished and lucid as possible. Finish your drafts early, give your friends and colleagues copies of your essays for criticisms, incorporate several rounds of feedback into your revisions, and spend lots and lots of time editing. There is no magic here. You want to approach your global maximum quality by repeated iterations.

  Note for non-native English speakers: If English is not your native language, give your essays to a trusted friend and ask him/her to revise portions that just sound awkward. Trust me ... there will be parts that sound awkward! It's often little things like the use of the wrong preposition or incorrect idiomatic uses of phrases that alert the reader that the writer is not a

native English speaker. These fellowships are all provided by patriotic American institutions, so it's helpful to not egregiously stand out as a foreigner. I mean, you can't really mask your race or background because you need to provide your name, birthplace, and other demographic info, but you don't want to give the reviewers any additional subliminal reasons to not take your application as seriously as possible. Most of your competitors will be native English speakers who can write 'American-sounding' prose, so if you can't, then you may be at a slight disadvantage. The reviewers understand that you are not writing a work of high literary art, but they are likely biased, however subconsciously, in favor of English prose that just 'sounds more natural'. Don't be prideful or ashamed about asking your American-born friends to correct your written English if necessary --- it may mean the difference between winning and almost winning a fellowship. Your grammar and spelling abilities are probably better than many of your American-born peers, but they have the native-tongue advantage that cannot easily be learned in adulthood.

- o **Coherence**: The first two C's, Completeness and Clarity, will take you pretty far, but this last C, Coherence, will win you the game. You need to make your entire application tie together coherently. It should not be a disorganized brain dump of all the information you wanted to include (Completeness), even if it is well written (Clarity). You want the reviewers to read your application and come away with a strong, coherent image of you as a passionate young researcher, not just as yet another applicant with a laundry list of disparate accomplishments. You want them to be able to concisely argue a case for why you should receive a fellowship. To do that, you will need your application to present a coherent portrait of yourself as someone with potential to perform significant research.

  Make yourself memorable by giving the reviewers something to remember you by. Hammer in your main strength or passion via repetition in the short answers, essays, and in your reference letters (write down the relevant info so that your letter writers can incorporate it into their letters). You may be good at a lot of things, but don't try to focus on them all, because then it sounds like you're mediocre at everything. Pick one or two strengths and drill them in via repetition, and only mention others in passing. Always remember *show, don't tell*, so don't ever toot your own horn without backing it up with solid evidence. You may really be earnestly interested in curing AIDS in Africa, but it's useless to mention that in your app (and it makes you sound insincere) if you haven't actually done any AIDS-related research, traveled to Africa to help out with AIDS patients, etc. Show, don't tell.

  Most importantly, make cross-references in different parts of your application, so that these parts reinforce each other and provide an interconnected web of coherent information about yourself. This will help the reviewers in remembering you; hopefully they will read some part of your app and say, *"A ha! I remember, he mentioned this point earlier in the short answers, and it ties well into his current research. Cool. This guy is on top of his game."* Don't go overboard and try to stretch to draw connections where there are none, but whenever possible, relate parts of your applications to other parts and provide smooth and sensible transitions. For example, if you are describing 3 research projects you were involved in, perhaps each one

taught you skills that motivated you to pursue more advanced or detailed research, thus enabling you to move on to the subsequent project. This progression lends itself well to powerful, memorable transitions. Or if you are involved in volunteer work related to some topic, perhaps you can weave a connection to some previous research you've done or some club you've led. There is no formula for doing these cross-references well; it's a holistic process that's unique for every applicant. But I think that these links really help to make your application more coherent and memorable.

So ... what are my chances?

Like parenting, the fellowship application process is something in which nobody can claim to be a scientific expert ... because of the simple fact that nobody has enough sample points to make any statistically significant claims. A parent can only raise at most a handful of children, all in one of many possible environments. Similarly, a fellowship applicant can only try for a handful of fellowships, all in one of many possible environments. Even if one raises an all-star child or wins a fellowship, it doesn't mean that he/she knows the sure-fire way to repeat those favorable results. There is definitely luck involved, and forces outside of one's control, such as the disposition and biases of the anonymous reviewers, the quality of the competition, etc. There is no algorithm for parenting, nor is there an algorithm for winning these fellowships. Every fellowship winner or loser is only one sample point. That is precisely why I stress the importance of picking many people's brains for advice, because the more sample points you collect, the better of an idea you will have in terms of your own chances.

Your chances might heavily depend on your major and even on your area of specialty. The NSF technically gives out awards for dozens of majors, but if you look at the lists of winners from previous years, you'll find that most are either in the 'hard sciences' (physics, chem, bio) or in some form of engineering (mechanical, aeronautical). If you happen to be in a major or specialty area that isn't too popular for funding agencies at the moment, then you might be facing an uphill battle. But, oh well, at least you're competing with others in your major who are in the same predicament as you.

I've also heard that where you are from, in terms of region of the country, also matters, because there might be some fuzzy algorithm that tries to balance out the distribution of funds to different areas of the country (so that they are not ALL concentrated in the prestigious New England and California research universities). Also, there may be subtle biases in favor of racial and gender diversity. **In sum, there are a lot of factors that are out of your control in the fellowship application process, so don't get stressed out by any of them. Just play the game as best as you can.**

Advice for the NSF Fellowship

General Philosophy and Format

Out of the 3 fellowships, the NSF seems like the one that stands up best to the ideal of science for the sake of science. They are a government agency with lots of money

to invest in the future of American science of all shapes and forms. In my year, the NSF application contained 3 essay questions. I wrote 2 pages (single-spaced, 12 pt. font) for each of them. The rest of the application (short answer and fill-in-the-blank questions) is pretty straightforward, so I will concentrate my advice on the essay questions.

Essay 1: Previous Research

Here is the prompt for 2005-2006 (it may differ for your year):

Describe any scientific research activities in which you have participated, such as experience in undergraduate research programs, or research experience gained through summer or part-time employment or in work-study programs, or other research activities, either academic or job-related. Explain the purpose of the research and your specific role in the research, including the extent to which you worked independently and/or as part of a team, and what you learned from your research. In your statement, distinguish between undergraduate and graduate research experience. If you have no direct research experience, describe any activities that you believe have prepared you to undertake research. At the end of your statement, list any publications and/or presentations made at national and/or regional professional meetings.

This essay is pretty plain vanilla. Just follow the prompt and write about all the research projects in which you have been involved, making sure to hit all the points the prompt requires. Briefly describe each project, your particular role in it, how much you worked per week, what you learned from the experience, what impact it had on the world (however small), how it motivated you to want to pursue a Ph.D. (if it did at all), etc.

The flow of my essay was one of build-up and climax. I wrote about 4 projects in chronological order, each one requiring more sophistication and experience than the previous one. The climax came as I described my most significant (which was my most recent) project. I spent the first page describing the first three projects, and the second page solely dedicated to describing the final and most significant one. I suggest devoting more space to your most significant project, because it emphasizes your greatest strength; it also provides good context for your next essay, *Proposed Research*, as well as ample space for making cross-references between your essays. Don't devote an equal amount of space to each of your projects unless you truly feel that they are all of equal significance.

If you have published (or submitted) papers, in addition to listing them at the end of this essay in a mini-bibliography like the prompt requires, make references to them in the essay itself in order to put those papers in their proper context.

Essay 2: Proposed Research

Here is the prompt for 2005-2006 (it may differ for your year):

In a clear, concise, and original statement, present a complete plan for a research project that you may pursue while on fellowship tenure and how you became interested in the topic. Your statement should demonstrate your understanding of

research design and methodology and explain the relationship to your previous research, if any. Describe how you propose to address the two NSF Merit Review Criteria of Intellectual Merit and Broader Impacts. Refer to the program announcement for specific guidance.

Format: Include the title, key words, hypothesis, research plan (strategy, methodology, and controls), anticipated results or findings, literature citations, and a statement attesting to the originality of the research proposal. If you have not formulated a research plan, your statement should include a description of a topic that interests you and how you would propose to conduct research on that topic.

Research topics discussed in your proposed plan will be used to determine eligibility. Refer to the Field of Study eligibility criterion in the program announcement.

This essay is a real doozie. It will take a lot of thinking, planning, and discussion with your advisor and colleagues to come up with a research proposal that makes for a strong essay. What the reviewers are looking for is whether you can write a technical proposal for a project that is feasible, impactful, and realistic given your particular expertise. However, nobody is going to follow-up with you and force you to *actually* work on the project you proposed.

I would strongly suggest writing a proposal that's somehow based on work that you have already done, so that you can tie it in with your *Previous Research* essay (cross-references!!!). In other words, don't just make up some cool topic out of thin air. If you're not that excited about your current work and desperately want to switch to something completely different once you start your Ph.D., now is *not* the time to express your discontent. It's dangerous to propose a research project that's not related to what you've already done because it dampens your credibility. Show, don't tell. If you make a proposal that's based on your current work, you have more opportunities to show rather than tell. However, don't fall into the trap of simply proposing a small step forward for your current research (a slight tweak here and there), because that just makes you sound lazy and unoriginal. The reviewers want to see something innovative. Don't be afraid to make a bigger, more ambitious conceptual leap, as long as it's grounded in your current work, even if you have no clue whether it's fully tractable to solve the problem you've proposed (just don't leap as far out as cold fusion or perpetual motion).

Oh yeah, you know how the prompt says: *If you have not formulated a research plan, your statement should include a description of a topic that interests you and how you would propose to conduct research on that topic.* Well, don't ever take this cop-out route! Formulate an actual research plan! Nothing is stopping you, other than lack of effort. Taking this cop-out route is a fast path to the land of loser.

A good research proposal will contain solid anchoring to your previous work, a well-motivated research problem, citations from 4 or 5 references to show that you are familiar with the body of existing work on this problem, and a proposed solution to the problem that sounds somewhat tractable. I know, 2 pages isn't much room at all, but everyone else has the same space constraints too.

The prompt wants you to satisfy the requirement of *Intellectual Merit*, but that is pretty straightforward. That simply means, write something that's technically competent and shows that you know what you're doing.

In order to satisfy the requirement of *Broader Impacts* in this essay, you will need to argue for why this research benefits society and the world (feel free to stretch a bit, but don't be too corny). And no, simply advancing the 'state of the art' in your field isn't sufficiently broad an impact, because that doesn't impact the people in the rest of the world who know nothing about your field. Think broader.

Essay 3: Personal Statements

Here is the prompt for 2005-2006 (it may differ for your year):

NSF Fellows are expected to become knowledge experts and leaders who can contribute significantly to research, education, and innovations in science and engineering. The purpose of this essay is to demonstrate your potential to satisfy this requirement. Your ideas and examples do not have to be confined necessarily to the discipline that you have chosen to pursue.

Describe any personal, professional, or educational experiences or situations that have prepared you or contributed to your desire to pursue advanced study in science, technology, engineering, or mathematics. Describe your competencies and evidence of leadership potential. Discuss your career aspirations and how the NSF fellowship will enable you to achieve your goals. Provide specific details in the narrative that address the NSF Merit Review Criteria of Intellectual Merit and Broader Impacts as described in the program announcement.

Ok, pay real close attention. **This is the essay that will make or break your application.** Stop laughing. I'm not kidding. It sounds like a foofy fluffy feel-good personal statement essay, but trust me, the people I knew who didn't take this essay seriously barely missed out on winning an award, getting an honorable mention instead and receiving written reviews along the lines of *"you're very strong technically, but you just don't have enough broader impacts."* Pretty much all top contenders are technically marvelous, so what makes the difference between a win and a near-win is *Broader Impacts*, which are best expressed in this essay.

See the next section for more details about Broader Impacts, but the name of the game in this essay is to incorporate as much Broader Impacts as humanly possible while still following the prompt. In previous years, there was a separate essay specifically asking you to address Broader Impacts, but in my year, they eliminated that essay, so this is your primary opportunity to discuss Broader Impacts.

Don't be too selfish in this essay; don't toot your own horn too much because the reviewers don't care about you as a person. Don't just make it all me, me, me, like about how deeply passionate you are about your field ever since you played with your first chemistry or electronics set when you were 6 years old. Instead, try to talk about your own work and interests in relation to other people, such as leadership, mentoring, TAing, learning from research colleagues, working on a team, etc. Show your passion for your field by cross-referencing your internship and research experiences (to weave together different parts of your app) instead of just recounting wonderful childhood nerd stories that nobody except your mother cares about.

The Importance of Broader Impacts

The definition from the 2006 NSF :

The broader impacts criterion includes contributions that (1) effectively integrate research and education at all levels, infuse learning with the excitement of discovery, and assure that the findings and methods of research are communicated in a broad context and to a large audience; (2) encourage diversity, broaden opportunities, and enable the participation of all citizens-women and men, underrepresented minorities, and persons with disabilities-in science and research; (3) enhance scientific and technical understanding; and (4) benefit society. Applicants may provide characteristics of their background, including personal, professional, and educational experiences, to indicate their potential to fulfill the broader impacts criterion.

Broader Impacts (mostly expressed within your *Personal Statements Essay*) makes or breaks your application. Alone, it cannot secure you a victory, but coupled with great technical qualifications (the other criterion, *Intellectual Merit*), it can vastly improve your chances of winning. Every single person whom I've asked about the NSF fellowship tells me to spend lots of time thinking about and addressing Broader Impacts. They've told me stories about how their friends barely missed winning because their Broader Impacts weren't, well, broad enough. You must infuse Broader Impacts throughout all of your essays, but the *Personal Statements Essay* gives you the most opportunities to do so. Let's go through the 4 parts of the criterion one-by-one:

1. *effectively integrate research and education at all levels, infuse learning with the excitement of discovery, and assure that the findings and methods of research are communicated in a broad context and to a large audience*
   - This means not only that you should be enthusiastic about learning for your own hot self, but more importantly, that you should be enthusiastic about sharing knowledge with others. TAing, tutoring, and mentoring are good examples. Even better, if you have done anything with science education, especially for children in underprivileged areas, that would be golden. This should go in your *Personal Statements Essay* and in your short answers about your teaching experiences.
2. *encourage diversity, broaden opportunities, and enable the participation of all citizens-women and men, underrepresented minorities, and persons with disabilities-in science and research*
   - I think that this is the most influential point in Broader Impacts. The diversity point. This should definitely go in your *Personal Statements Essay*. Find SOME way to incorporate this point. If you are a woman, part of an underrepresented minority, or have some disability, now is the time and place to mention it somehow (always tastefully and sparingly, of course; it should not be your main selling point). Have no fear or shame. This is a game, and your strongest competitors who are in these demographics will mention their minority status. I know NSF winners in these demographics who've told me how they mentioned their status in their essays, even though they felt that it sounded a bit cheesy. Whatever. It's better to be a bit cheesy and win over $100k than to stubbornly stick to your principles and lose out. After all, the primary criteria for evaluation is your technical merit, so if you are really well-qualified anyways, nobody should think that you got this fellowship 'just because you're part of X or Y group'. What if you aren't part of any underrepresented minority? Well, think about anything you have done to

promote diversity in science and education, and write about those experiences (if any).

3. *enhance scientific and technical understanding*
   - This one is like doing science for the sake of science. Don't worry about it too much because the boring technical aspects of your application, such as your *Previous Research* and *Proposed Research* essays should cover it pretty well.

4. *benefit society*
   - This is really about the impact of your work, both previous and proposed. Remember: impact, real world impact. You're not doing science in a bubble.

Out of all 3 fellowship applications, I spent by far the most time on the NSF. It was definitely time well spent, though, because it made doing the other 2 applications, especially the NDSEG, much easier.

Advice for the NDSEG Fellowship

General Philosophy and Format

Despite its military-sounding name, I've heard that the NDSEG actually has fairly civilian intentions: The fellowships are given out to ensure that America has a steady supply of capable future scientists, because presumably America will be a stronger and safer place if our best and brightest don't escape to other naughty countries to make doomsday weapons for them. So don't worry. If you win this fellowship, you won't have to enlist in the military for mandatory service or anything. This application isn't due until January (after all your grad school apps), so if you've done a solid job on the NSF and Hertz applications, it should be trivial to fill out this one (there are no long essays, only a few short essays and fill-in-the-blanks). You can easily finish it in a few days over winter break.

You don't need to tailor your application specifically for the military

When working on this application, don't treat it like the military brass or super-duper-hardcore patriots will be scrutinizing you, waiting to pick out any glimmer of sedition. Don't try to purposely impress them by casting your accomplishments in military terms (unless, of course, your research really does have direct military applications). Just relax and don't let the name of the fellowship intimidate you. As far as I know, respectable scientific researchers will be reading your application, just like for the NSF.

Study what the funding agencies are looking for

The area of specialty you choose to write in really matters a lot. Here is why ... taken from a passage from the *Proposed discipline & area of specialization* section of the NDSEG application instructions:

2. Area of specialization - Describe your area of specialization, if any, within your chosen discipline. For example, an applicant applying within the Physics discipline

might enter 'optics' or 'acoustics' in this text box. If you do not have an area of specialization, enter the discipline.

To learn more about the areas of interest to the DoD, applicants are encouraged to consult the Broad Area Announcements for the Army Research Office (http://www.aro.army.mil), Office of Naval Research (http://www.onr.navy.mil), and the Air Force Office of Scientific Research (http://www.afosr.af.mil).

Okay, you have a text box where you can write down the name of an area of specialization. Don't take this decision lightly. You need to write down an area which, (1) you can promote strongly with evidence in your application, and (2) one of the three funding agencies (Army, Navy, or Air Force) is likely to fund. Go visit the websites of these agencies and look up what areas of specializations are especially hot for funding by them at the moment.

Please, please don't write down a specialization that doesn't appear in any of these funding agencies' lists; that's a quick ticket to the land of loser. Ideally, you want to write down a specialization that appears in all 3 funding agencies' lists in order to give yourself the broadest possible appeal. If you're really doing research that doesn't appeal at all to any funding agency, then you will need to tweak your application so that it matches some specialization that they are willing to fund.

Advice for the Hertz Fellowship

General Philosophy and Format

The Hertz is the mack daddy of the 3 general science fellowships, with the most money, most prestige, and least number of winners (a measly 10-15 per year as compared to the 200 for NDSEG or 1,000 for NSF). It is given out by a private foundation that offers money to the best and brightest in applying the physical sciences to empower and protect America. I think it's the most patriotic out of all 3 fellowships, so keep that in mind as you are working on it.

The most unique portion of the application process is the two rounds of interviews. Approximately 800 students apply for the fellowship, and about 1/4 of them (200 people) are selected for a first-round interview. 1/4 of those (~50-60 people) pass onto the second-round interview. Then 1/4 of those are picked as the final awards recipients (~10-15 people). Yeah, so the selection process is pretty darn difficult and mostly out of your hands. I made it to the first-round interview and was then rejected.

The Application

The written application isn't brain surgery or anything. Just put your best foot forward as a smart, passionate, patriotic American student of science. Keep in mind what the Hertz Foundation means by the *application of the physical sciences* (read their website again and again until you're no longer puzzled) and try to portray how your own research and interests fit this requirement.

The First-Round Interview

I was fortunate enough to be picked for a first-round interview. This interview is usually held at some local hotel and lasts 1 hour. Your interviewer will be a researcher who is most likely a former Hertz fellow. Wear a suit. It's pretty formal. This is no time for funny business. There's really not much you can do to prepare. It will be a technical interview, so he/she will prepare questions for you to answer. You can spend some time at the beginning of the interview describing your own research, but the primary purpose of the interview is for the interrogator to grill you with math, physics, chemistry, and other science questions and assess how well you think about solving problems.

Because the Hertz emphasizes a physical science education, you should know basic physics and chemistry pretty well if you want any chance of advancing past the first-round interview. You won't have to do surface integrals or anything, just basic algebra, but you'll have to remember basic physics equations like $F=ma$ and friends. You should also study up on some basic probability theory, because people often get asked questions about probability as well. They are testing how well you think about solving problems, not necessarily if you can get them correct, but of course, if you answer correctly, it will be to your benefit! In short, there really isn't any way to prepare for this interview. You either know stuff, or you don't. It's really a crapshoot, so just treat it as a fun experience and don't get too stressed out if your interviewer seems antagonistic. It's his/her job to push you hard and see how you react.

One last bit of advice I've heard is that you should bring several intelligent questions to ask your interviewer. At the end of the interview, he/she will ask you to ask some questions of your own, about the foundation, the fellowship, or whatever else you want. Come prepared so that you don't just sit there like a rock for a minute and then sputter out something lame like *"Uhhh, were you a Hertz fellow? How did you like it?"*

The Second-Round Interview

Ummm, I didn't get this far, but I do know people who have. They've told me that it's a pretty intense grilling. The interviewers turn up the heat much more than they did in the first round so that only the strongest survive. If you get this far, then I'm no longer qualified to provide you with advice. Just do your best and hope that you are one of the lucky 1/4 picked to receive the award.

Acknowledgments

Links

Here are some other pages that might be useful for fellowship applicants:

- Jean Yang's site containing her NSF application essays; she won the NSF fellowship in 2008 for Computer Science and is now pursuing her Ph.D. at MIT.
- Rachel Smith's site containing NSF application essays and feedback in assorted fields.

Feel free to send comments, suggestions, questions, or rants to me via email: philip@pgbovine.net

Here are some email responses to this article.

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