

National Science Foundation Graduate Research Fellowship Program

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What is Fundamental Research?

What is NSF?

- ✓ Advancing the state of the art in some area of knowledge
 - Improves health, prosperity, and welfare
 - Should be useful in some direct or indirect manner!
 - The burden of proof rests on the investigator (the scientist)
 - Is not problem-specific
 - This is tricky for engineers
 - Trickier for researchers-to-be

- ✓ NSF is a federal funding agency to support research in all fields of fundamental science and engineering, except for medical science
 - Founded in 1950 to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...

Eligibility Requirements & Deadlines

- This is **NOT** a comprehensive list
- Sole source of information is the Program Solicitation (**NSF 21-602** for 2021)
 - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf21602
 - (Just search “NSF 21-602”)
- ✓ Must be U.S. citizen, national, or permanent resident
- ✓ Intend to enroll or be enrolled full-time in a research-based master's or doctoral degree program in an eligible Field of Study in STEM or STEM education
- ✓ Never applied to GRFP while enrolled in a graduate degree program
- ✓ Never earned doctoral, terminal, or master's degree or professional degree in any field, or completed more than one academic year in a graduate degree-granting program (**Some exceptions apply**)
- ✓ **Deadlines**: 10/18/2021 – 10/22/2021 (**Each area has a specific deadline**)

What is in the application package?

1. Transcripts
 2. Statement of “Personal, relevant background, and future goals” (3 pages)
 3. “Research plan” (2 pages)
 - Including references
 - Must be proposing original work
 4. Reference letters
 - Not less than 2
 - 3 is preferable (typical)
 - No more than 5
- All important components
- All tricky components

Let's look at them

NSF Template: Graduate Research Plan Statement

“Present an **original research topic** that you would like to pursue in graduate school. Describe the research **idea**, the proposed **approach**, and **resources** needed to accomplish the research goal, including access to national facilities or collections, collaborations, overseas work, etc. You may cite **references**. Address the potential of the research to **advance knowledge and understanding [intellectual merits]** within science as well as the potential for **broader impacts** on society. The research must be in a field listed in the Solicitation (Section X, Fields of Study).”

Length = 2 pages

1. Background (with references)
 - Scientific (or sometimes practical) **motivation**
 - Demonstration of research **understanding & gaps/questions**
2. Research objectives/Specific aims (ideas)
 - **Novel & significant/challenging** work scope (for a PhD)
3. Plan (by objectives/aims usually)
 - **Scientific & credible approaches/steps** (with references)
 - **Resources:** facilities, equipment, data sources, participants... (**reasonable for you** to access/generate)
4. Intellectual Merits (knowledge)
 - **New, specific, and important** knowledge that overcomes theoretical, methodological, and/or empirical challenges
5. Broader Impacts
 - **Practical significance:** Safety, productivity/economy, health, sustainability, equity... (e.g., my data curation method for machine learning would reduce bias loan access and thus equity in housing and wealth)
 - **Citizenship:** History and plan for promoting science/STEM via outreach and education (e.g., K1-12 summer camps, conference organization...)



What should a research plan **say about you?**

*GRFP awards a fellowship for **someone with great potential** to conduct any research, not a great research plan for anyone to conduct.*

- I can **comprehend/explain** science (literature review)
- I can **innovate** (novel research ideas/aims)
- I can **practice** science (executable plan)
- I can **contribute to science** (importance/merits of your work)
- I can **impact** the world (relate science & work to society)

Personal, relevant background, and future goals

Today is the first day of your future, not the last day of your past – Dr. L’Afflitto :-D

- You are applying for funding to support your future graduate studies
 - You are not applying for a monetary award for your past!
 - You will be awfully original by **not** starting with “Since I was [2, 3, 6, 8, etc.]”
- Start each paragraph with a clear statement
 - There is no time and space for preambles, personal historic perspectives, etc.
 - **Bold keywords**, underline relevant parts of sentences
 - Give a title to each paragraph
 - E.g.: “**Educational objectives.** I am applying for a Ph.D. degree because I want to become a leading scientist in [your field] and solve [this challenging problem]. I have been pursuing this objective since...”
- Use facts from your past to prove your passion, commitment, and potential for success

How I would structure my personal statement (1/4)

- **Career goals.** I aspire to become a professor in robotics and lead my scientific community to the design of autonomous cobots to help people at home and work. I have been having this ambition...
- **Path to my career goals.** I plan to attain my goal by attending [Virginia Tech] and developing the research plan outlined in my Research Plan with the help of [Dr. XXX]. After that, I plan to work as a post-doctoral researcher at a top-tier university in the US for 2 years, and finally apply for a faculty position. [Continue elaborating on your future in grad school and beyond] To support my plans, in grad school I will study [Dynamics, linear and nonlinear control, optimal control, multi-body dynamics, mechatronics... ***Be specific***] because [show links to your research]
- **Prior research experiences.** From [Year] to [Year] I performed undergraduate research with [Dr. XXX] on [topic]. My role was [....]. Our results appeared [...]
 - Here you start showing your understanding of the proposed research problem
 - Here you can present some references (you have 3 pages!!)

How I would structure my personal statement (2/4)

- **Relevant past coursework.** As an undergraduate student, I took classes in [name relevant classes] and my GPA for these classes was [X.YZ/4.00]. In [class], I lead a project on [add topic and description]. As a graduate student, I successfully passed [name relevant classes]. By studying these subjects I appreciated [robotics] because [your reasons] and understood that this discipline is currently limited by [your research problem], which I would like to address with my research.
 - Give links to **YouTube videos** of **class projects** or **independent work**
 - Give links to **webpages** of **class projects** or **independent work**
- **Extra-curricular experiences.** From [Year] to [Year] I have been a team member for the [robot soccer competition]. I started as a junior designer, and then [show progression]
 - Give links to **YouTube videos**
 - Give links to **webpages**

How I would structure my personal statement (3/4)

➤ **Intellectual merit.** By devoting my professional career to robotics and the design of cobots, I plan to **advance knowledge** in robotics by solving [name your broad fundamental research problem], the first of which is [name the research problem you propose] that I discuss in my Research Plan. These problems have been investigated by [reference], but more research must be done because [**explain why your research has not been done yet**]. I plan to [explain step by step your approach to professional goals and give a timeline (immediately after graduation, 2, 5, 10 years later, etc.)]

- **Mandatory section**
- Show clear ties to I.M. of your proposed research
- “Advance knowledge” is a **keyword**
- How did successful faculty/researchers make it?
 - Check their websites or LinkedIn pages
 - Project their path onto yours

How I would structure my personal statement (4/4)

- **Broader impacts.** I strongly believe in the need for research to be useful. Furthermore, I advocate for the importance of **encouraging others to a career in STEM** the same way as I was encouraged. Indeed,
- Name societal benefits of your research. [My cobots will help elderly at home and will give them company]. Give detailed explanation
 - Name how you are already giving back to society. [I am a member of (name association) and (frequency), we (describe activities as a group). My role is to (describe your role).]
 - **Mandatory section**
 - Show clear ties to B.I. of your proposed research
 - “**STEM**” (Science, Technology, Engineering, and Math) is a **keyword**
 - Elaborate on your activities to support **underrepresented minorities**
 - Research & broader impacts **not necessarily closely connected**

Excellent *detailed* reference letters are absolutely critical for a successful application, so how do you get these?

1. Wise choice of reference letter writers is critical!

- People may think highly of you, but **all letter writers** must understand that this is a very specific type of NSF reference letter. They must provide **details** of your contributions and demonstrated leadership, not just general accolades (i.e. “very smart” “hard worker” etc is not enough)!
- Request letters from faculty who are very familiar with you and your research. ***A research advisor is best and essentially required, especially with regards to your proposed research area.***
- Letter writers with PhDs who have/or are doing extensive research (and likely submitting NSF proposals) are generally your **best** choices.
- Faculty that can speak to your leadership and innovation on a design project *may* be a reasonable 3rd, 4th or 5th option (***but be careful*** – they must really understand the nature of research and NSF; often someone with only/primarily industry experience may not appreciate the nuances here). Additionally, an extraordinary letter from someone in a significant role (like a faculty member or dean) that can speak to your leadership in outreach *may* also be a reasonable 3rd, 4th or 5th option.
- ***Not good choices*** (generally) are: People who only know you as the “A” student in class (“who enthusiastically answered questions”), people not involved with much or any research (such as engineers working in industry positions), people who have not yet advanced into a prestigious career (such as a head camp counselor, or the chair of your fraternity’s/sorority’s food drive, etc).
- Make sure you have the maximum amount of letters allowed! **Too few means automatic rejection of application without review**, and having less than what you are allowed will negatively impact application for some reviewers.

When requesting a letter, be clear to your reference that this is more than just a graduate-school application letter

2. Once you have identified references, asking them involves providing them with clear details of what they will need to do to write a strong letter!

- Explain that for you to be competitive for this fellowship, **all reference letters must go into specific detail describing your accomplishments**
- At the time of your request, refer your reference to the tutorial video on the NSF website on writing reference letters for NSF GRFP here: https://nsfgrfp.org/reference_writers/reference-writer-tutorial/
- At the time of your request, also provide references with the NSF-instruction link on what to include: https://nsfgrfp.org/reference_writers/requirements/ (and actually cut and paste the info in this link into an email to them to make it one-step easier)
- Offer (politely) to give them a draft or outline of a letter with some details, but be careful! Same draft to different faculty could result in letters that are too similar. Also, make sure you know what a good reference letter looks like (do your own research on this!).
- Give them an “out” : “I understand you are very busy, and that you may not have the time to do the type of letter required by NSF. Please let me know by *date* if you will be able to do this by the deadline of *due date*.” *While a “no” may be frustrating to you, think of it as likely eliminating an insufficiently strong letter.*
- Be proactive! **ASK EARLY** and send a couple of friendly reminders about due date. Make sure faculty submit!
- **Be clear to faculty in your research area, such as your advisor, that they will need to explain that your research proposal is yours and explain how it is different from their own work/ideas**

3. Never too late to “grow” your references! Assume you will submit again (or that you will need reference letters for other opportunities). Be proactive at making successful research contributions, be proactive at disseminating your work, try and find a successful older graduate student (or two) as a mentor (just offer to buy them coffee for some advice!), foster good relationships with faculty. ***Strategize and act on how you will demonstrate leadership in research (intellectual merit) and outreach (broader impacts)?***

Student Experience (1/3)

Personal Introduction

- Graduated from RWU in 2018:
 - Broader engineering background than many schools (degree in engineering with a specialization in electrical engineering).
 - Was able to get my name on a few conference papers.
- 4th year Ph.D. Student in the Engineering Mechanics department working in Dr. Nicole Abaid's Complex Systems Lab
- Current research is in robotic sensing and control:
 - Bioinspired bat like ultrasonic sensing.
 - Investigating combination of active and passive sensing in multiagent systems.
- Applied in second year giving me a whole year to learn about research background and have a more solid plan and experience:
 - Had already attended a conference
 - Had received a NSF International Research Experience for Students (IRES) fellowship to work with another professor, Dr. Rolf Mueller, in China.

Student Experience (2/3)

Research Proposal

- One sentence objective at top of proposal
 - “Explore control algorithms for a multi-agent robotic team equipped with bioinspired sensing capabilities.”
- Question/Hypothesis that will be answered by your research
 - “Can a multi-agent system outfitted with bat-like sensing accomplish canonical robotic swarm tasks and possibly outperform other systems with traditional sensing?”
- Background/Introduction:
 - Provide a broad area of current research that your research fits into
 - Briefly review some published research and how your proposal will build on top of what exists.
- Research Plan:
 - I provided four aims, with the final being more of a brief “reach goal”, which laid out a concise loose timeline of projects that built on top of one another.
- Intellectual Merit:
 - How will your work build upon your field “fundamentally”
 - Brief sentence about how your work will challenge you to grow which will then allow you to continue to contribute to your field.
- Broader Impacts:
 - Can be difficult to defend as some research can become very specialized.
 - Again, may be helpful to include how this research will allow you to grow and create a broader impact.

Student Experience (3/3)

Quick Advice

➤ Tell a story!

- Personal statement is almost like a biography of how you've grown personally and academically into someone capable of performing your proposed research
- Research proposal should have experiments/aims that expand on each other or come together to accomplish your final stated objective.

➤ Use every sentence to share new information, you have less room than you think.

➤ Don't be afraid to brag a little and be confident in your proposal:

- I literally used the words "novel paradigm" in my proposal introduction.

➤ Connect everything together (statement, proposal, references) so your submission is a complete package.

➤ Make sure you've worked with references in a meaningful way, a professor you've had for one course probably won't be the most useful even if they liked you and you did well.

- I used my undergraduate advisor, the professor I worked with in China, and my current advisor.

➤ It's research, things won't always work out exactly as planned and that's ok.

➤ Helpful Website: [Alex Lang's Website - NSF Fellowship \(alexhunterlang.com\)](http://alexhunterlang.com)

A Path to a Successful Application

- Be involved in research early-on (also as an undergrad)
- Show knowledge of the literature
 - ✓ Ask yourself what has not been researched yet and why
 - ✓ This is difficult and it requires a lot of time, effort, conversations with adviser
- Be a leader/role model in non-research related topics
 - ✓ Associations, clubs, tutoring
- Have clear ideas about your future as a researcher

Questions?



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