

Grant Writing for Computer Scientists: Mixed Metaphors and Road Rules of Thumb

**Jason Hale
March 23, 2013**

Opening Statement

Grants are external investments that can propel your novel ideas into discoveries, innovations, and positive impacts to society.

But, they aren't just giving them away. You have to compete for them. The grant proposal is your primary tool in this competition.

Several metaphors and heuristics may help you think about how to develop and sharpen this tool.

Use of Metaphors for Software Development

A confusing abundance of metaphors has grown up around software development. David Gries says writing software is a science (1981). Donald Knuth says it's an art (1998). Watts Humphrey says it's a process (1989). P. J. Plauger and Kent Beck say it's like driving a car, although they draw nearly opposite conclusions (Plauger 1993, Beck 2000). Alistair Cockburn says it's a game (2002). Eric Raymond says it's like a bazaar (2000). Andy Hunt and Dave Thomas say it's like gardening. Paul Heckel says it's like filming *Snow White and the Seven Dwarfs* (1994). Fred Brooks says that it's like farming, hunting werewolves, or drowning with dinosaurs in a tar pit (1995). Which are the best metaphors?

McConnell

Use of Metaphors for Grant Writing

- The value of metaphors should not be underestimated. Metaphors have the value of expected behavior that is understood by all. – Fernando J. Corbato (McConnell)
- Tool metaphor
- Journalism metaphor
- Courtroom metaphor
- Software development metaphor

A grant proposal starts with a good idea

- It's the most important thing
- Learn to recognize your innovative ideas
- Listen to your own questions

Implementing the idea requires action and resources

- Funds for summer salary to conduct research
- Funds to recruit and hire students
- Equipment, services, supplies
- Programs (outreach, etc.)
- Etc.

Who funds Grants?

- Federal government agencies
 - Non-profit organizations
 - Private companies/corporations
 - State government
-
- Grant vs. Gift
 - Grant vs. Contract Services
 - Competitive vs. non-competitive

What is in a (typical) Grant Proposal?

National Science Foundation (NSF)

- Project Description (15 pages)
- Project Summary (1 page)
- Budget
- Data Management Plan
- Vitas and resumes
- Letters of support
- Etc.

National Science Foundation (2012)

- ~48,000 proposals
- ~250,000 reviews (~5 per proposal)
- ~11,000 awards
- 24% funding rate (research 21%)
- Average annual award: ~\$165,000
- Average duration: ~3 years

Sweet Sixteen

- Ole Miss Basketball 2012-13
 - 27 wins – tied for most in school history
 - Won SEC tournament
 - Didn't advance to sweet sixteen
 - Wouldn't have been funded by NSF
- Some NSF programs fund only ~10%
- Some NIH programs fund only ~6%

There's always next year

Proposals to NSF

- 1st time funding rate: 15%
- 2nd time funding rate: 50%
- 3rd time funding rate: 75%

NSF Merit Review Principles and Elements

Is it worth doing?

- **Intellectual Merit**: Novelty and power of the idea to **advance** or transform **knowledge**
- **Broader Impacts**: potential to **benefit society** or advance desired societal outcomes (**happy side effects**)

NSF Merit Review Principles and Elements (cont.)

Can *you* actually *do* it?

- Is there a thoughtful **plan**?
- Does the team have the **qualifications** to do it?
- Are there adequate **resources** to do it?

How will we know if you really did it?

- Ability to assess success and measure impact

Metaphor for the Grant Proposal: Courtroom Trial

Your **argument/brief** to the **jury** before the **judge**
why your **accused client** should be **vindicated** and
awarded damages.

Your **proposal** to the **reviewers** before the **program**
officer why your **research project** should be **funded**.

Metaphor for the Grant Proposal: Courtroom Trial

Your research (**literature review**) and courtroom strategy (**idea/plan**) should identify witnesses (**scholars**) and facts (**published research data, findings, and well-sourced facts**) that expose holes in the case against your client (**identify gaps in knowledge**) and testify to client's good character (**inspire confidence in ability of your team/project to fill the gaps**).

Metaphor for the Grant Proposal: Courtroom Trial

As with a courtroom trial, you cannot interact with the reviewers. They can't question you, and you can't respond to their criticisms

The courtroom metaphor has some limits...

You cannot directly examine witness or re-cross-examine witnesses whose credibility has damaged.

Instead, your proposal has to do all your talking for you, and must be able to defend itself to scrutiny.

It must be both offensive, and defensive, all at once.

Metaphor for Grant Proposal: **Software Program**

The **interface** and **implementation** of a **software program** with your **design** and **code**, conforming to an **environment**, along with **documentation**, to meet the **requirements** of **users** specified by a **lead user**, evaluated by a set of **test users**, who will **recommend to buy** either our product or one of your competitor's.

Activity

Metaphor for Grant Proposal: Software Program

The interface **project summary** and implementation **narrative** of a software program **research proposal** with your design **approach/plan** and code **words**, conforming to an environment **proposal format**, along with documentation **budget, supporting documents**, to meet the requirements **solicitation** of users **a sponsor** specified by a lead user **program officer**, evaluated by a set of test users **reviewers**, who will recommend to buy either your product **fund your grant** or your competitor's.

Mixed Metaphors?

Read the writing on the wall +

Wake up and smell the coffee =

Wake up and smell the coffee on the wall.

Green + Wet behind the ears = Green Behind the Ears

Journalism Metaphor: Don't Bury the Lead



Don't Bury the Lead

- Journalists use Inverted Pyramid style
- “Lede” is journalism term
- Front-load your proposal with the most important points first; the rest is just supporting information
- Don't assume anyone is interested in what you have to say. If you can make them interested, great. If not, make sure they know what you intend to do by reading the first few sentences.

Don't Bury the Lead

- Find your key point and bring it to the front
- Let others help find your point
- This is what I'm going to do.
- This is why it is important.
- This is how it relates to but is different than what has been done before.
- Tell how the project's side effects will transform the institution, lives, and the world.

Courtroom: Make a Strong Opening Statement

- A Few Good Words
- Crisp. Clear. Memorable.
- Lens through which to view all that is to follow.



Make a Strong Opening Statement

Within the theme of aquatic environmental protection, we will create a diverse pipeline of problem solvers with the skills and experience to:

- understand big-picture environmental problems;
- identify research questions critical to solving those problems;
- assemble, lead, and serve on diverse solution teams; and
- engage stakeholders to ensure adoption of solutions for maximum societal impact.

Make a Strong Opening Statement

Project Description (400/375):

The Office of the Governor will lead a public/private partnership to establish a Middle Mile broadband infrastructure that will geographically cover 97% of the state, transform education, public safety, and health care in Mississippi, create jobs in economically distressed areas, and enable Last Mile service by commercial providers to unserved and underserved rural areas.

NSF Project Summary: The User Interface

Overview

- The opening statement goes here!
- 1-2 sentences
- Concise; easy to understand; memorable;



Intellectual Merit Statement

- What is the problem/knowledge gap
- What is your great idea
- How will it advance/transform knowledge

Broader Impacts Statement

- How it is going to change the world (specifically)

NSF Project Summary: The User Interface

Should be understandable by your mother-in-law

After one reading, your mother-in-law should know enough about what you are planning to do to discuss it at bridge club with her friends.

Proposals that do not contain the Project Summary, including an overview and separate statements on intellectual merit and broader impacts will not be accepted by FastLane or will be returned without review²¹. Additional instructions for preparation of the Project Summary are available in FastLane.

Remove Jargon from Summary

With Moore's Law no longer describing the rate of increase of speed of individual cores, programmers have to look for other ways to increase the speed of our ever-more-complicated applications. The functionality provided by the CPU manufacturers is an increased number of execution units, or CPU cores. To use the extra cores, programs must be parallelized.

Any jargon here?

Remove Jargon from Summary

With **Moore's Law** no longer describing the rate of increase of speed of individual **cores**, programmers have to look for other ways to increase the speed of our ever-more-complicated applications. The functionality provided by the CPU manufacturers is an increased number of execution units, or CPU cores. To use the extra cores, programs must be **parallelized**.

Re-Write?

Remove Jargon from Summary

Programmers are recently looking at ways to increase the speed of ever-more-complicated applications on modern computers. For decades, computer manufactures were able to provide the needed speed-up in the hardware, through ever-faster generations of processors. These days, companies are unable to produce faster processors (or “CPU cores” as they are now known); instead, they are producing more CPU cores per computer. The speedup problem has thus shifted from a hardware realm to a software challenge: programmers must build applications that can finish faster by running on multiple CPU cores “in parallel” (at the same time).

Avoid Giving Opinions

The proposed project is the single most important opportunity our state has to simultaneously transform its educational, research, healthcare, and public safety landscape, through the creation of a combined network of fiber optic and wireless towers that will place middle mile anchor institutions geographically throughout Mississippi and ultimately provide coverage to 97% of the state..

Comment [11]

Can you link this to any statewide action plan or official document that states these objectives as a statewide goal?

Comment [10]

Avoid sweeping statements and rhetoric.
Make as fact-based as possible.

Very Strenuously Object to Almost All Adverbs

- A Few Good Men: 1:13:14
- Use facts instead
- The users should draw their own conclusions
- Some adverbs to watch out for:

clearly, importantly, significantly

Limit Descriptive Adjectives (Replace Descriptors with Limiters)

Partners include the nonprofit Mississippi Economic Growth Alliance Point of Presence (MEGAPOP), the Mississippi Wireless [Communication](#) Commission (WCC), the Mississippi Research Consortium (MRC, representing the four research universities), the University of Mississippi Medical Center, and the Mississippi Department of Information Technology Services (ITS), with strong support from numerous other organizations in the public and private sector

Comment [7]

The term **numerous** is too vague. Avoid non-descript terms and be as specific as possible.

Some adjectives to watch out for:

numerous, significant, important, useful, exciting, several

Limit Descriptive Adjectives (Replace Descriptors with Limiters)

A group of tick researchers at UM has offered an exciting course on ticks, edited a useful handbook on ticks, developed several outreach programs, and collaborated on lots of research.

A group of tick researchers at UM's has offered an **exciting** course on ticks, edited a **useful** handbook on ticks, developed **several** outreach programs, and collaborated on **lots of** research

More than words

“Saying I love you
Is not the words I want to hear from you
It's not that I want you
Not to say, but if you only knew
How easy it would be to show me how you feel
More than words is all you have to do to make it real
Then you wouldn't have to say
that you love me
'Cause I'd already know”



Don't TELL the reviewers you and your idea are awesome, interesting, and significant. SHOW them, through facts, publications, data.



Be Specific

UM's Ticks from Other Worlds Research Group:

- published 15 tick-related articles in peer-reviewed journals, including 5 articles with undergraduate co-authors, and one with an undergraduate, Hispanic student as the lead author [REF]
- developed a 500-level interdisciplinary course called “Genetic Tick Engineering,” which has been offered 10 times since 2005 and completed by 500 students in both chemistry and engineering programs.
- developed an e-handbook: “How to Kill a Zombie Tick,” which has been downloaded 15,000 times to Apple, Kindle, and Blackberry devices.

Be Specific

- with 5 senior Native American women students, built a traveling “TickMobile” that has so far shown 1,000 kindergartners in Northeast Mississippi how to safely extract ticks from themselves or other children on the playground;
- developed the “Tick Engineering Camp” through which they have recruited 10 students (including seven women and one African American) into the Center for Manufacturing Engineering; and
- sponsored Brad Paisley to the Oxford Science Café in 2012, where he performed his song “I’d Like to Check You for Ticks” for the over 100 community members.

NSF Broader Impacts Interests

Increasing participation in STEM (computing) programs and careers

- African Americans
- Women
- Hispanics
- Native Americans
- Native Alaskans and Hawaiian Islanders
- Persons with Disabilities

Research Opportunities for Undergraduate Students

K-12 STEM Outreach Programs

Increasing institutional, regional, & national research infrastructure

Benefiting society

Broader Impacts Credentials: examples

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Among the K-12, undergraduate and graduate students in the PI's group, more than 50% of the students are from underrepresented female and African American groups

The PI has mentored four high school, nine undergraduate, and four graduate students to date, over 50% of whom are from underrepresented groups and this commitment will continue during this project period.

List SPECIFIC Broader Impacts

Mississippi leads the nation by far in the percentage of residents who are African Americans: 37%. (Louisiana is second next at 32%).

At the University of Mississippi, over the past 10 years (2002-2011), minority enrollment has increased by 78.9 % and African-American enrollment is up 84.0%. Last fall, 24.2% (nearly one in four) of UM students were minorities and 16.5% were African-American.

We will develop a K-12 outreach program of science demonstrations at the North Panola high school, North Panola Junior high school and Green Hill elementary schools. 97% of the students at these schools are African American and 87% qualify for free lunch programs. Through this outreach program, we will try to recruit these students into our high school, undergraduate and graduate programs.

Gather and (Re)Use Facts

Women enroll at disproportionately lower rates in engineering, computer sciences, physical sciences, and economics. (NSF)

"Foreign students earned 57% of all engineering doctorates, 54% of all computer science degrees, and 51% of physics doctoral degrees. Their overall share of S&E degrees was one-third." (NSF)

By 2020, employment in all computer occupations is expected to increase by 22%. (ComputerWorld)

The number of people employed as computer programmers will increase by 12% (the smallest in the IT field) through the decade, from 363,100 in 2010 to 406,800 by 2020, the BLS projects. (ComputerWorld)

Read, know, and live the External Requirements (solicitation, proposal development guides, etc.)

- Is cost share required?
- What documents are required?
- May (will) facilities and administrative costs be collected to reimburse the institution for the costs of supporting research?
- Review criteria?
- Deadlines (including times)
- Required documents
- Etc.

Learn the Internal Requirements (UM/MS)

- Who will cover the cost share?
- How can federal grant funds be spent at UM on personnel, fringes, equipment, services, commodities, travel, tuition, etc.
- Institutional deadlines (including times)
- Research integrity and compliance
- Intellectual property & confidentiality protection
- Academic requirements/restrictions
- Etc.

Know and Respect Resource Constraints

- Pages/words/margins

NSF: 15 page description + 1 page summary

- Cost sharing? F&A costs? (29%, 44%, 50%)
- Your Program Development Specialist is a

Time Shared Resource

- She may SEEM like she's only there to serve you
- But she also serves a dozen or so other departments
- So don't wait til the last minute to ask her for help or bring her a proposal to submit

Writing Tight, Efficient, ~~On-Time~~, Early ~~Code~~ Proposals

“Well those drifter’s days are past me now

I’ve got so much to think about

Deadlines and commitments

What to leave in,

what to leave out”



What to leave in

- What we propose to do.
- Why it is important.
- What knowledge gap it will fill.
- Why we have what it takes to do it.
- How we plan to do it.
- How much:
 - Cost: to you (the sponsor); to us (the institution)
 - Expected Return on Investment: how much this will advance the frontiers of knowledge & change the world.

What to leave out

- Voltaire said that a book is finished not when nothing more can be added but when more can be taken away (McConnell, 2004)
- “Everything should be as simple as possible, but no simpler.” – Albert Einstein
- Ruthlessly eliminate duplicate program code ([proposal text](#))

Who is Your Precious?

Your reviewers may represent your most precious resources!

Reviewers have:

- Limited attention spans
- Limited cognitive capacity (because they are human)
- Limited time
- Limited goodwill; and
- A huge stack of proposals to review.

Be Kind to Your Reivewers

- Polish code by carefully formatting and commenting it.
(McConnell)
- Tune code to make it faster and use fewer resources
(McConnell)
- Tune and format text to make it faster **to read** and use fewer **mental** resources **to understand** and **love**

Plan to Throw One Away; You Will, Anyhow

(Fred Brooks)

“For most projects, the first system built is barely useable: too slow, too big, too hard to use, or all 3. It ends up being discarded and redesigned. The discard and redesign may be done in one lump, or piece-by-piece, but it will be done.”

Similarly, by the time you submit a GOOD proposal, it might be the 15th, 20th, or 30th revised version.

So, leave plenty of time for reviews and revisions.

If you plan to throw away 1, you will throw away 2

(Craig Zerouni)

McConnell thinks planning to throw one away leads to less careful planning and design and more expensive trial and error.

Better to get those reviews internally, and do the rewrite before sending to NSF.

But, even if you don't like it, its better to submit it to NSF and get the reviews than to wait til next year—because that one is going to need be rewritten, too.

Especially, the Summary. Start early!

Miscellaneous Metaphors and Heuristics

- Iterative Prototyping and Code Reviews

Circulate proposal drafts early and often for review.

- Modular, Structured Programming

Use thoughtful subsections, bullets, headers, indentation, tables, and figures to improve readability.

- Defensive Programming: *read like a reviewer to find and fill holes*

- Take a Shot. Ideally, a good shot but don't wait for the perfect shot.

You can't get an award if you don't submit.

- Crash the Boards to get Offensive Rebounds. *Revise and resubmit.*

- Publish Continuously to establish credibility w/reviewers

- Be an NSF grant reviewer to see lots of good (and bad) proposals

- If English isn't your first language, find a strong writer to help you.

You've Got a Friend in your Research Advocate

Dr. Helen Kiss



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