

Writing More Effective Grant Proposals: Tips and Metaphors for Computer Scientists

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Opening Statement

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

The grant proposal is your primary tool in this competition.

Several tips and metaphors may help you 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

Types of Research

- Basic Research (to better understand the riddles of nature; to advance knowledge for knowledge's sake;)
 - Example: discovery of DNA
- Applied Research (to solve specific problems) Federal government agencies
 - Examples:
 - Search for cures for disease
 - Predict (or measure) environmental impact of oil spills

Who funds Grants?

- Federal Government
- Non-profit organizations
- Private companies/corporations
 - Sponsors may be less patient
- State government

- Grant vs. Gift
- Grant vs. Contract Services
- Competitive vs. non-competitive

Federal Government Sponsorship of Research

- NSF, NIH, DoE, DoD, DoC, Education Dept., etc.
- Funds for basic research down 25% in last 4 years, to \$30B/year
- No earmarks
- Politicized (Sequestration, etc.)
- Interested in distributing money [kind of] fairly (geography, race, gender, etc.)
- Most of research funding still comes from feds
- Bureaucratic

Non-profits and Individual Philanthropists

- Kellogg Foundation, Bill & Melinda Gates Foundation, Ellison Medical Foundation, etc.
- Often funded by billionaires who want to “give back” or who have pet cause they want to advance
- Alternative to harder-to-get federal funds
- Trendy or “sexy” projects
- Projects to solve problems that disproportionately affect the wealthy?
- Less bureaucratic?

Corporate/Industry

- Seagate, Intel, Google, Microsoft, Facebook, Oracle
- Motivated by making money
- IP issues (negotiate these early)

Types of Grants

- Research
- Education
- Development/Infrastructure
- Service
- Fellowships

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.

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
- [UM Center for Educational Research & Evaluation](#)

7 Tips and Metaphors

1. Tip: Have and communicate an innovative idea
2. Tip: Make a strong opening statement
3. Tip: Avoid editorializing (stick to the facts)
4. Tip: Be kind to your reviewers: Be Clear and Concise
5. Tip: Be specific
6. Tip: Develop your Broader Impacts

Tip: Have and communicate an innovative idea

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

Tip: Have and communicate an innovative idea

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**)

Tip : Make a strong opening statement

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: Courtroom Trial

Your **research** and **courtroom**
strategy should identify **witnesses**
and **evidence**
that **expose holes**
in the case against your client
and **testify your client's good character**

Metaphor: Courtroom Trial

Your **research literature review** should identify **scholars, published research data, findings, and well-sourced facts** that identify **knowledge gaps or capability gaps**.

Your **idea, goals, objectives/aims, proposed activities, and management plan** should inspire reviewers' confidence in **your ability to fill the gaps**.

Metaphor: Courtroom Trial

As with a courtroom trial's jurors, 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.

Therefore,

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

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

Courtroom Metaphor: Make a Strong Opening Statement

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



Courtroom Metaphor: 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.”

Courtroom Metaphor: Make a Strong Opening Statement

“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.”

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.

Exercise: Can you spot 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).

Create a Checklist

		Present, Clear, & Strong	Could Be Presented More Clearly	Somewhat There But Hard to Find	Hinted or Not Clear	Absent
Goals	Will lead to significant and sustainable improvements in STEM Learning					
	Will contribute to improvements in the nation's formal education system					
	Will advance STEM teaching					
	Emphasize research on innovative STEM resources, models, and/or tools					
	Emphasize development of innovative STEM resources, models, tools					
	Builds upon educational research (theory, knowledge, findings)					
	Promotes effective STEM practices in diverse preK-12 classrooms					
	Is high risk/return project that could radically transform formal STEM Education					
Musts	1st sentence of summary should state the type of proposal AND the strand addressed					
	2nd sentence of summary should state the discipline(s) and grade level(s) addressed					
	Intellectual Merit explicitly addressed in separate summary statement					
	Broader Impacts explicitly addressed in separate summary statement					
	Summary and Project Description adhere to formatting requirements					
	Project Description begins with a research question or hypothesis about preK-12 STEM learning					
	Proj. Descr. Addresses Importance, including:					
	- how project has important STEM focus					
	- how project addresses critical educational needs					
	- why project has the potential for broad impact					
	- what the goals of the project are, AND					
	- why the goals are important for STEM education					
	- provide a rationale for how project will:					
	- improve STEM education for students					
	- advance knowledge					

Be Specific

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.

Exercise: What words in the text above are **too general (not specific enough)**?

Be Specific

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

Tip: 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 and Head Start students 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 Excellence; 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.

Be Specific: List Specific Broader Impacts

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

Be Specific: Broader Impacts examples

Among the K-12, undergraduate and graduate students in the PI's group, more than 50% of the students are females or members of underrepresented minorities

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.

Be 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.

Be Specific: 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)

Tip: Avoid Editorializing

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.

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Avoid sweeping statements and rhetoric.
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Very Strenuously Object to Almost All Adverbs

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

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]

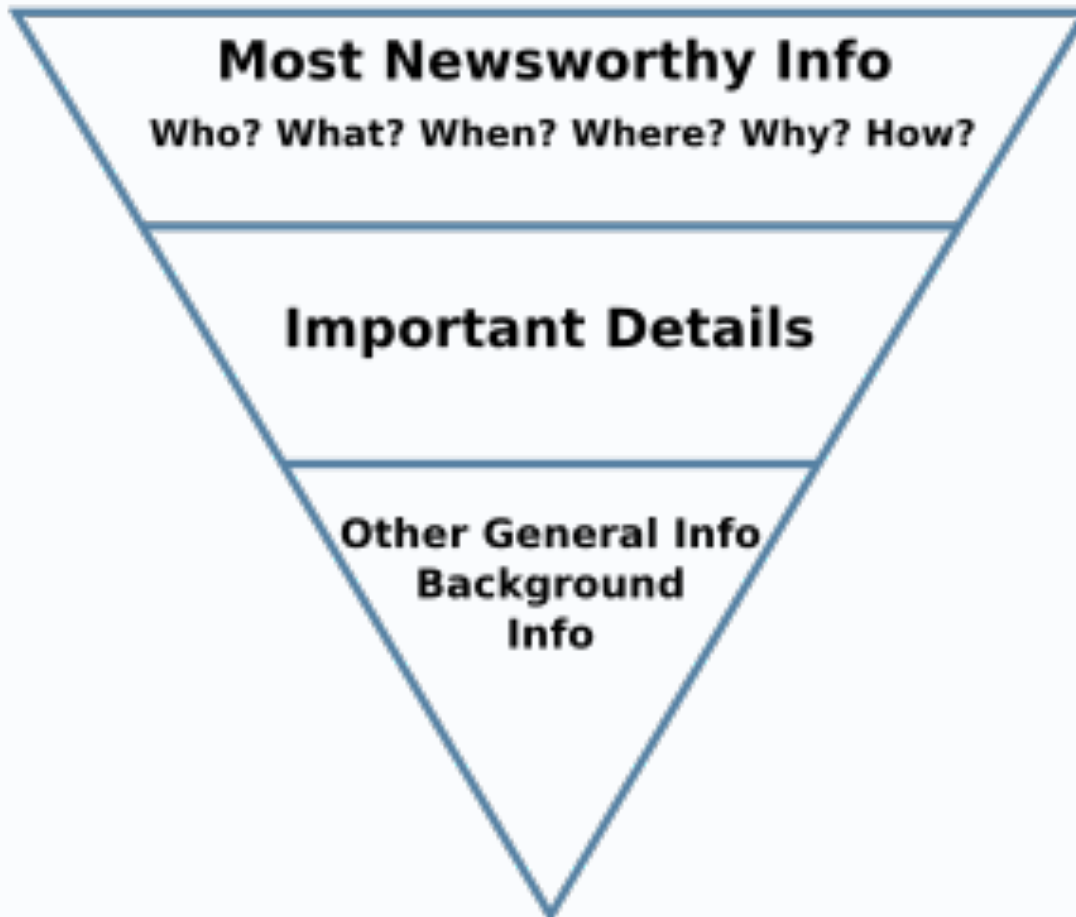
The term **numerous** is too vague. Avoid non-descript terms and be as specific as possible.

Some adjectives to watch out for:

numerous, significant, important, useful, exciting, several

Journalism Metaphor: Inverted Pyramid Style

Journalists use *Inverted Pyramid Style* for news stories



Journalism Metaphor: Don't Bury the Lead

Front-load your proposal with the most important points first; the rest is just supporting information

Do not assume everyone is interested in what you have to say; do not assume all reviewers will read your entire proposal.

If you can interest them, great. If not, make sure they learn your intentions by reading the first few sentences.

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.

Journalism Metaphor: 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.*
- *This is how the project's side effects will transform the institution, lives, and the world.*

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.

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

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.

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.

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 grandfather or mother-in-law

After one reading, he/she should know enough about what you are planning to do to discuss it at bridge club or bingo with his/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.

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

Be Kind to Your Reviewers

- 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**

Be Kind: 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.

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](#))

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.

A Few Good Tips

- Circulate proposal drafts early and often for review.
- Use thoughtful subsections, bullets, headers, indentation, tables, and figures to improve readability.
- Read like a reviewer to find and fill holes
- Revise and resubmit.
- Publish Continuously to establish credibility w/reviewers
- Become 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.
- Even if English IS your first language, find a strong writers to read, comment, and edit your proposal.
-

Metaphor of Love: 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.



You've Got a Friend in your Research Advocate

Dr. Helen Kiss



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