Writing a Compelling Proposal

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George Heilmeier
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- RCA Laboratories – invented LCDs
- Director of DARPA
- VP and CTO of Texas Instruments
- CEO of Bellcore

- IEEE David Sarnoff Award
- National Medal of Science
- National Academy of Engineering Founders Award
- IEEE Medal of Honor
- Kyoto Prize
- National Academy of Engineering Charles Stark Draper Prize
What are you trying to do? Articulate your objectives using absolutely no jargon.

How is it done today? What are the limits of current practice?

What’s new in your approach? Why do you think it will be successful?

Who cares? If you’re successful, what difference will it make? What impact will success have? How will it be measured?

What are the risks? Why might you not succeed?

How much will it cost?

How long will it take?

What are the midterm and final exams to check for success? How will progress be measured?
1: Pick good problem(s)

- why is the problem important?
  - what happens if you do not solve this problem?
  - why should anyone care?
- new fundamentals/principles involved?
  - universal truths (best) versus point solutions (not as good)
- a problem area with “legs”?
  - once you’re done, is story over, or is this fundamental work leading to lots of future work?
  - are you setting a foundation?

A fool can ask more questions in a minute than a wise man/woman (or a Yoda) can answer in a lifetime
2: Every proposal tells a story

- what is the “elevator pitch” of your proposal (reviewers, PDs)?

- story is not what you will do, but rather
  - what you will show, new ideas, new insights
  - why interesting, important

- why is story of interest to others?
  - universal truths, hot topic, impact, surprises or unexpected results

- know your story!
3: **What** will you do, and **how** will you do it?

- basic questions all reviewers will ask
- so *ask and answer these questions* for the reviewers in your proposal

**what** – questions to be addressed

**how** – methodology to address questions how is it done today
4: Specific research questions

- clear problem statements: pose questions, show initial results, demonstrating methodology
  - questions alone aren’t enough (anyone can pose questions – how will you address them)
- some near-term problems that you have an idea how to attack
- list longer term problems that you may only have vague idea of how to solve
  - showing longer term issues is important
5: Initial work: must be done before proposal

- initial results demonstrate feasibility
  - illustrative, explanatory to reviewer
  - provide intuition about what you will do

- but if the problems are basically solved already, then it’s not proposed research

- illustrate approach(es) to solving problems
  - show you possess right skill set
6 Past work

- be specific about past related work, how proposed research differs
  - reviewers are knowledgeable, aware of past work (may have done the past work you are citing!)
  - what is the value added of proposed work (not just difference)

"What Descartes did was a good step. You have added much .... If I have seen a little further it is by standing on the shoulders of Giants."

Sir Issac Newton, 1676
7 Introduction: crucial, formulaic

*If the reviewer is not excited by intro, proposal is lost*

- recipe:
  - *para. 1*: motivation: broadly, problem area, why important?
  - *para. 2*: narrow down: what is problem you specifically consider
  - *para. 3*: “In this proposal, we ….”: most crucial paragraph, tell your elevator pitch
  - *para. 4*: how different/better/relates to other work, at high level
  - *para 5*: summarize contributions at higher level, long-term 10K ft view of contribution: change the world!
  - *para. 6*: … remainder of proposal structured as follows …
8 Broader impact

- important review criteria: will be explicitly addressed in proposal evaluation

- know what a broader impact *is*:
  - [http://cisebroaderimpacts.org/](http://cisebroaderimpacts.org/) - CISE-specific wisdom/examples of broader impacts
  - goes beyond your teaching responsibilities

- critical for large- (and medium-) sized proposals
  - poor broader impacts can sink a proposal
  - smaller proposals: BI impacts tend to be more formulaic

- leverage institutional resources/programs
  - you don’t have to do it alone and it can be an idea/effort proven to work
9. Submit to a program funding the research you propose

- understand goals of program/solicitation
  - ask people who know, don’t assume or guess
  - essential for cross/special programs
  - what/who has been funded recently
  - communicate with program directors

- if your research fits into more than one core program, communicate with relevant program directors before the submission
  - proposals don’t always get moved or shared
10. Know the review process

- proposals can get sorted and assigned to panels based on the information in the summary
- reviewers may read 10-15 proposals (lots of work, tiring)
  - interesting, fun/pleasant to read proposals a rarity
- reviewers will typically be panelists present at NSF (virtual panels as appropriate)
- rank proposals and bin: highly competitive, competitive, (low competitive), not competitive
11. Put yourself in place of reviewer

- less can be more
  - “I would have written less if I had had time”
- reviewers shouldn’t have to work
  - won’t “dig” to get story, understand context, results
  - need textual signposts to know where ‘story” is going, context to know where they are
    - good: “e.g., Having seen that … let us next develop a model for …. Let Z be …. ”
    - bad: “Let Z be”
- what does reader know/not know, want/not want?
  - write for reader, not for yourself
12. Put yourself in place of reviewer

- page upon page of dense text: **no fun** to read
  - avoid cramped feeling of tiny fonts, small margins
  - create openness with white space: figures, lists

- provide enough context & information for reviewers to understand what you write
  - no one has as much background/content as you
  - no one can read your mind
  - define all terms/notation
13. Master the basics of organized writing

- paragraph = ordered set of topically-related sentences
- lead sentence
  - sets context for paragraph
  - usually ties to previous paragraph
- sentences in paragraph should have logical narrative flow, relating to theme/topic
- don’t mix tenses in descriptive text
- one sentence paragraph: warning!

“No tale is so good that it can't be spoiled in the telling”
Proverb
14. Write top down

- computer scientists (and most human beings) think this way!
- state broad themes/ideas/questions first, then go into detail
  - context, context, context
- even when going into detail … write top down!

The Elements of Style
by William Strunk E. B. White
(50 years old – and still a classic!)

Writing for Computer Science
by Justin Zobel
15. Good proposal writing takes time

- give yourself time to reflect, write, review, refine
- give others a chance to read/review and provide feedback
  - get a reader’s point of view
  - find a good writer/editor to critique your writing
  - you may get contradictory advice
- starting proposal two weeks before deadline, while ideas/results still being generated: non-starter
- get a “red team” review a week before it’s due
16. Learn from Declinations

- It’ll happen now and then, for the rest of your professional life
- Learn from a declination
  - Why was paper/proposal rejected?
  - What did/didn’t reviewers see/like?
  - Talk to the program director
- ….. but don’t write assuming the same reviewers will review your proposal (paper). They won’t!
Perspective of an NSF DD on junior PIs

- successful PIs:
  - choose a good problem related to their expertise but not continuing the PhD research
  - get mentoring and help in preparing a proposal
  - are enthusiastic about research

- junior PIs: likely to get benefit of the doubt in core programs
  - in larger efforts, a junior PI is generally not a good idea

- if a proposal is declined
  - getting verbal feedback from the program director is crucial: helps understand the reviews
  - don’t take a declination personally: many good proposals don’t get funded

- submit a career or a small core proposal?
More words of wisdom …

- process of writing a proposal improves the research!
- read the solicitation, know the proper home for your proposal
  - know special preparation and evaluation criteria
  - talk to cognizant program manager
- have a really good (required) one-page summary upfront
  (intellectual merit, broader impacts)
  - all reviewers will be asked to answer these questions
- use an example that shows *richness* (but simple enough for reader to understand), *threads through proposal to provide unity/common thread*
More words of wisdom …

- volunteer to be a proposal reviewer
  - better yet: have someone send your name to the right person
  - you learn by seeing the process
- teaming up with a more experienced researcher on a first proposal can be good start
- generating proposals
  - great idea (great) versus “there’s deadline” (harder)
Take home messages

- choose your problems and program carefully
- be bold and remember the big picture
- demonstrate proficiency, vision
- present a clear plan for research, with preliminary work
- write *extremely* well
- advice/feedback from mentors, experienced faculty in your research area
- put yourself in the place of a reviewer
- get feedback from program manager if declined
- remember Heilmeier’s Catechism
“Heilmeier Catechism”

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