Writing a Competitive Proposal

MSEC/NAMRC
College Station, Texas
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Why are we here?

• To better master proposal writing, and to increase the chance of success for each submitted proposal
• Many persons submitting proposals to NSF demonstrate an inability to properly frame their research, resulting in relatively poor ratings
• Today’s goal is to help people to write more competitive research proposals that clearly articulate their goals, objectives and tasks
Today’s focus

• Writing compelling goals and objectives
  – Stating research objectives
  – Framing your approach
  – Writing the summary page

• We will also touch on other aspects of a proposal and on ethical conduct of research
Necessary conditions

• To get money from a federal agency
  – The agency must have money to give you
  – There must be a law allowing the agency to give you the money
  – The agency must have a mechanism to transfer the money to you
  – The agency must have an interest in what you offer
  – You must submit a written proposal
The NSF Act of 1950

To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Act of 1950".

ESTABLISHMENT OF NATIONAL SCIENCE FOUNDATION

SEC. 2. There is hereby established in the executive branch of the Government an independent agency to be known as the National Science Foundation (hereinafter referred to as the “Foundation”). The Foundation shall consist of a National Science Board (hereinafter referred to as the "Board") and a Director.

FUNCTIONS OF THE FOUNDATION

SEC. 3. (a) The Foundation is authorized and directed--
to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;
to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such basic scientific research and to appraise the impact of research upon industrial development and upon the general welfare;
Mandatory reading

• Proposal and Award Policies and Procedures Guide (PAPPG)—be sure to get the latest version (currently NSF 18-001)
• Research 101 for Engineers
• Announcement or solicitation
Proposal

• A proposal is an offer to provide property, service or other item of value in return for compensation of some sort (typically money)
• A proposal must state the offer and the compensation
PAPPG requirements

• “The Project Description should provide a clear statement of the work to be undertaken and must include the objectives for the period of the proposed work and expected significance; the relationship of this work to the present state of knowledge in the field, as well as to work in progress by the PI under other support.”

• “The Project Description should outline the general plan of work, including the broad design of activities to be undertaken, and, where appropriate, provide a clear description of experimental methods and procedures. Proposers should address what they want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful.”
Important elements of a proposal

• What is being proposed (a research objective)
• How will it be accomplished
• Evidence that the proposer can do it
• Evidence that it is worth doing
• How much it will cost (the budget)
What do reviewers review?

• Reviewers ask themselves four questions regarding a proposal:
  – What is it about—what is the research objective?
  – How will the PI accomplish the objective—will the proposed tasks, if carried out competently, accomplish the objective?
  – Can the PI do it (knowledge, skills, facilities, etc.)?
  – Is it worth doing (for the science—intellectual merit, and for society at large—broader impacts)?
Components of a successful proposal

• A clearly written research objective
• A well designed plan to accomplish the stated objective
• A well articulated argument that you can carry out your plan competently
• A well articulated argument that the research is worth funding
  – For the engineering/science (intellectual merit)
  – For the benefit to society (broader impacts)
Stuff you should know

• Before you begin to write a proposal:
  – Are you eligible for an award?
  – Which is the right program for your proposal?
  – Can you submit your proposal on time?
  – What is the budget limit?
  – What are the mandatory sections of a proposal?
  – What must you do to have a competitive proposal?
  – What should you do to have a competitive proposal?
Two key questions

• What is the difference between a goal and an objective?

• What is research?
Goals and objectives

- Goal: To stay dry
- Objective: Replace the leaky roof over your head
- The goal is what you want to achieve, the objective is how you intend to pursue it
- Goals motivate objectives
- Objectives frame tasks
- We pursue goals, we achieve objectives
- There may be many ways to pursue a goal, but few ways to achieve an objective
Goals, objectives, tasks

- **Goal:** Stay dry
  - **Objectives:**
    - Move to desert
    - Replace leaky roof
    - Buy umbrella
  - **Tasks:**
    - Remove old shingles
    - Install new shingles
    - Clean up the mess
Example—install a new roof

• High-level tasks
  – Remove the old shingles
  – Install new shingles
  – Clean up the mess

• Lower-level tasks
  – Remove the old shingles
    • Protect foundation plantings
    • Remove shingles
    • Cover exposed areas
    • Pick up nails
  – Etc. for other high-level tasks
My thesis goal and objective

• Goal: To enable preliminary mission planning for exploration of our solar system—mission planners were finding it essentially impossible to solve the mathematical problem of space trajectory optimization

• Objective: Use a Poincaré expansion to provide an analytical solution to the calculus of variations formulation of the trajectory optimization problem for the case of finite thrust
Exercise

• Which of the following is a goal, and which is an objective?
  – To gain improved knowledge about machining
  – To measure tool wear
  – To test the hypothesis that cutting tool rake surface temperature is the dominate factor in rake surface wear
  – To advance the technology of additive manufacturing
  – To measure cutting tool temperature as a function of spindle speed and depth of cut for specific material-tool combinations
  – To show that the addition of nanoparticles to lubricants can improve their lubricating qualities
  – To understand residual stress in additive manufacturing of metal objects
  – To use decision theory to determine stopping conditions for chemical-mechanical polishing (CMP) of IC wafers
Exercise

• Write the goal and objective of your PhD thesis
NSF funds basic research

• The NSF Act allows NSF to fund “basic research,” not development
• Your proposal to NSF must propose research
• You must have a research objective
  – The research objective is a statement of what you intend to accomplish
• What is research, and what is a research objective?
What is research?

• Research is the process of finding out something we don’t already know
  – Research is a process
  – The outcome of the process is knowledge

• Scientific research has three properties
  – Methodical (can be planned in advance)
  – Repeatable (results are not random)
  – Verifiable (conclusions based on tangible evidence)

• I do not distinguish between basic and applied research
Research vs. development

• I do distinguish between research and development
• If the result of your project is an artifact—a device, a product, a system, a process, an algorithm, etc.—it’s probably development
• If the result of your project is new knowledge, it’s probably research

A research objective is a knowledge objective
Exercise

• Which of the following are research objectives and which are development objectives?
  – To develop a new, highly efficient approach to solving nonlinear optimization problems
  – To use dynamic control of cutting tool vibrations to delay the onset of chatter
  – To measure cutting tool vibration at the onset of chatter
  – To test which fundamental laws of nature dominate the determination of cutting forces
  – To model additive manufacturing processes
  – To minimize distortion in additive manufacturing resulting from residual stresses
What is...?

• What is science?
• What is mathematics?
• What is engineering?
Science

• Science is the pursuit of knowledge about nature—the world around us, it is the search for the fundamental laws that govern the behavior of things
• Science is based on the assumption that all the laws of nature apply everywhere all the time
• Thus, laws of nature are there to be discovered
• Evidence: we can observe about $10^{31}$ cubic light years of space and 13 billion years of time, and see no evidence to the contrary
Science

• Science involves observation—physical measurements:
  – Temperature, pressure, voltage, magnetic field, weight, mass, etc.
• We derive laws of nature by unifying observations, i.e., by finding a common explanation for seemingly disparate observations
• Example: Newton’s apple vs. the motion of the planets
Science research

• Science research typically consists of hypothesis testing
  – A hypothesis regarding nature is posited
  – A test is designed
  – Experiments are conducted, measurements taken
  – Experimental results are compared with the hypothesis (the theory)
Mathematics

• Mathematics is about thoughts, thoughts are not physical, we do not measure them in physical terms
• Mathematics is the “science” of consistency
  – Arithmetic is a framework for thinking logically about cardinal numbers (quantities)
  – Geometry is a framework for thinking logically about shapes
  – Statistics is a framework for thinking logically about the past, what conclusions are consistent with data
  – Probability theory is a framework for thinking logically about the future (a calculus for manipulating beliefs)
Mathematics

• A mathematic (a logic system) is created based upon a set of fundamental beliefs—axioms—from which theorems are proven

• The theorems are the operative constructs of the mathematic

• The objective is to be able to draw conclusions that are entirely consistent with a specified set of beliefs and conditions
Mathematics research

• Mathematics research generally consists of extending the scope of our ability to “think” rationally, i.e., consistently

• A conjecture is formulated within a logic system, e.g., the four-color conjecture

• If the conjecture is proven, it becomes a theorem

• We must recognize that there is no “correct” logic system such that all other logic systems are incorrect

• A logic system cannot be built upon conflicting beliefs (axioms)
Consistency doesn’t come easily

• Solve for the largest positive integer
• Let $n$ be a positive integer
• Every positive integer has a square, $n^2$, which is also a positive integer
• But, if $n$ is the largest positive integer, $n \geq n^2$
• This has one and only one solution, $n = 1$
• Ergo, 1 is the largest positive integer
Why do we care?

We do not want to draw conclusions or take actions that are inconsistent with our beliefs or valid data.
Connecting physics and mathematics

• Example: Michelson and Morley measure the speed of light and fail to detect any variation as a function of direction
  – Einstein internalizes this as: *the speed of light is the same in all directions*. Then he finds that, entirely consistent with this belief, mass and energy are the same thing, $E = mc^2$

• Galileo is often credited with making the connection between physics and mathematics
Physical science vs. mathematics

• Physical sciences are physical
  – They are “outside” our mind
  – They rely on observations and measurements
  – Observations and measurements provide data
  – Data do not provide understanding

• Mathematics are “inside” our mind
  – They consist of self-consistent (logical) thoughts
  – They are the source of all understanding

• They are both tools of engineering
Exercise

• Question—How do you know what you know?

• Question—If I say, “I know A is true,” and you say, “I know A is false,” can we both be right?

• Question—Is a Fuzzy Logic analysis a mathematically sound procedure, i.e., self-consistent?
Question

• Is a Fuzzy Logic analysis mathematically sound, i.e., self-consistent?
• Underlying premise (axiom): elements are not deterministically members of a set
• Number theory: elements are deterministically members of a set
• Fuzzy logic contradicts the axioms upon which numbers are based
• Ergo, it is inconsistent to use numbers or arithmetic in a Fuzzy Logic analysis
Exercise

Take 5 minutes. Think of a case in which you used a mathematical model. Why did you model? How did the model help?
Engineering

• Engineering involves the manipulation of nature to the benefit of at least some segment of humankind
• Engineers are the decision makers who affect the design that enables the beneficial manipulation of nature
• Engineers are decision makers
What is a decision?

• A decision is:
  – An irrevocable allocation of resources
  – A choice take from among a set of alternatives
  – A choice taken in the present to affect a more desired future state
## Decision vs. problem

<table>
<thead>
<tr>
<th>Problem</th>
<th>Decision</th>
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<tbody>
<tr>
<td>Solve</td>
<td>Make</td>
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<tr>
<td>Get a solution</td>
<td>Get an outcome</td>
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<tr>
<td>Based on laws of nature, mathematics and data or boundary conditions</td>
<td>Choice is based on available alternatives, beliefs and preferences</td>
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<tr>
<td>Solutions are right or wrong</td>
<td>Outcomes are good or bad</td>
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<tr>
<td>Solutions may be deterministic</td>
<td>Decisions always involve uncertainty and risk</td>
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Good decision making

• Good decision making demands good prediction
• Decisions are optimizations
• Good decision making demands optimization

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to," said the Cat.
"I don't much care where," said Alice.
"Then it doesn't matter which way you go," said the Cat.
"I'd much like to go somewhere," Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, "if you only walk long enough."

What is engineering research?

• Engineering research supports design decision making

• Engineering research revolves around two key questions:
  – How to predict the outcomes of engineering decisions, e.g., the behavior of an engineering system?
  – How to make effective decisions in complex engineering situations

• These questions are unique to engineering
The bridge example

• We teach a 3-credit course on the equation $F = 0$
The bridge example

- We teach a 3-credit course on the equation $F = 0$

- But real structures all have volume
The bridge example

- Fact: we have no way of solving the equation $F = 0$ for all points in the bridge, we must approximate
- Research question: how can we apply the belief $F = 0$ in a real bridge with sufficient accuracy to enable good engineering decision making?
- Real cases always involve uncertainty
An engineering problem

• You are designing an airplane. Question: how much will it weigh?

• We cannot weigh the airplane until it is built, we cannot build it until it is designed, we cannot design it without knowing what it will weigh. What to do?

• Use a mathematical model. Hypothesis: the weight of the airplane equals the sum of the weights of its parts.

\[ W_A = \sum W_i = W_T \]
Testing the hypothesis

- We conduct experiments, weigh existing airplanes, disassemble them, weigh their parts, sum these weights

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<tr>
<th>Acft #</th>
<th>$W_A$</th>
<th>$W_1$</th>
<th>$W_2$</th>
<th>...</th>
<th>$W_T$</th>
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</table>
Testing the hypothesis

- The data and the theory agree within measurement accuracy. Can we conclude that the hypothesis true?

The theory, $W_A = W_T$, encompasses an infinity of points. $n$ tests comprise 0% of infinity. Ergo, the test does not prove the truth of the hypothesis, but neither does it falsify it. In general, the conclusion of an hypothesis test is, (a) the hypothesis is falsified, (b) the test failed to falsify the hypothesis.
Tasks follow from the objective

• Objective: to test the hypothesis
• Tasks:
  – Create a mathematical model
  – Obtain experimental data
  – Compare the two
• Reviewers should be using the tasks to evaluate whether the plan will meet the objective, they should not be using the tasks to determine the objective
A predictive model

• Given excellent agreement between the theory and the data, we are inclined to accept the theory as predictive

\[ W_A = W_T = \sum W_i = W_1 + W_2 + W_3 + \ldots \]

• But the \( W_i \) are random variables, thus this equation cannot be correct

• Correcting the equation yields, e.g.,

\[ E\{W_A\} = E\{W_T\} = \sum E\{W_i\} = E\{W_1\} + E\{W_2\} + \ldots \]

• This equation cannot be objectively validated
  – Knowing the true result doesn’t help
  – Expectations require multiple trials, based on the untestable assumption of IID variables
It’s easy to show that errors resulting from the neglect of uncertainty are unbounded.

Typical error:
- 20-50% on mass
- 2-10 on cost
Stating a hypothesis

• A typical scientific (engineering) hypothesis takes the form: $A = B$
  – Mass is energy, $E = mc^2$
  – Force is rate of change of momentum, $F = d(mv)/dt$

• A typical scientific hypothesis is falsifiable
  – “Can” renders an hypothesis unfalsifiable: By adding nano particles to aluminum, I can make it stronger
A valid hypothesis

• A valid hypothesis takes the form: $A = B$
• A valid hypothesis is falsifiable
• For an acceptable hypothesis, the test of the hypothesis can be planned in advance of the conduct of the test
• The plan to test the hypothesis is the research plan of the proposal

All our knowledge of nature is built upon unfalsified hypotheses
Exercise

• Which of the following are valid scientific hypotheses?
  – Light is an electromagnetic wave
  – Metals are stronger than plastics
  – Fatigue life of metals can be predicted
  – Fatigue life of metals is determined by peak cyclic stress
  – Global temperatures are correlated to atmospheric CO$_2$
  – There is life after death
Stating a research objective

- The objective of this proposal is to test the hypothesis...
- The objective of this proposal is to measure $P$ with accuracy $A$.
- The objective of this proposal is to prove conjecture $C$.
- The objective of this proposal is to apply method $X$ from field $Q$ to solve problem $Y$ in field $R$. 
Poorly stated research objectives

• This is probably the hardest part of the proposal!

• Poorly stated objectives:
  – The research objective of this project is to create novel new transformational knowledge in mechanics.
  – The objective of my research is to provide a quantum leap in the design of fracture-resistant composites.
  – The objective of this project is to develop an integrated modeling tool for the hardening process in light-weight alloys.
  – The goal of this project is to develop innovative advances to enhance multifunctional behavior in two-dimensional materials.
  – The aim of this project is to develop a universal theoretical framework to describe the fracture behavior of ductile and brittle materials.
  – The objective of this proposal is to design fast optimization algorithms for model predictive control of power electronic converters implemented in field-programmable gate arrays.
Better research objectives

• How to do it right:
  – The research objective of this proposal is to test the hypothesis that deformation process x dominates the creep behavior at high temperatures in y types of alloys.
  – The research objective of this proposal is to test the hypothesis that physical phenomena x,y,z dominate the chip formation process in the machining of brittle materials.
  – The research objective of this project is to use Monte Carlo analysis to relate the effect of variability in fiber distribution and size to the delamination strength in carbon nanofiber reinforced composites.
Warning

Don’t use words in your statement of your research objective that mean “not research,” e.g.:

- Develop
- Design
- Optimize
- Control
- Manage
- Build

These are not knowledge verbs
Making the connection between the objective and research tasks

• If the research objective is properly stated, the research tasks should be obvious

• Hypothesis: the tasks define the test of the hypothesis
  – What theory/modeling is required?
  – What measurements must be taken?
  – What ranges of variables must be covered, how many data points provide a reasonable test of the hypothesis?

• This level of specificity enables reviewers to do a proper assessment of your proposal
A side note on hypothesis testing

• If you are going to do a hypothesis test, you need to learn to do it right
  – You must state a scientific hypothesis
  – You must state a testable hypothesis—one for which you can write a plan
  – Recognize that you can falsify the hypothesis or fail to prove it—generally a well stated hypothesis cannot be proven true
  – The test of the hypothesis needs to be well planned
  – Ref: Karl Popper
In order to understand the research you are proposing, you must understand the context within which it is framed.
Example hypothesis and research plan

• Example hypothesis: *Cutting tool rake surface wear rate is dominantly a function of rake surface temperature*

• Research plan:
  – Derive, from first principles, a wear model and solution
  – Plan a series of tests to cover a range of variables
  – Compare experimental results with theory

• Difficulties:
  – Measurement of rake surface temperature is impossible
  – Quantification of rake surface wear
A hypothesis test

• Hypothesis: For a given cutting tool-material combination, the probability of chatter is a function of spindle speed and depth of cut

Context

Prediction—to understand which laws of nature dominate specific situations and to enable a predictive model.
Example measurement and research plan

- **Example measurement:** *Measure cutting tool rake surface temperature at a point within .05 mm beneath the tool surface accurate to 10 deg. C*

- **Research plan:**
  - Develop a temperature sensor that can be embedded in the tool
  - Fabricate test tools
  - Design and conduct a set of tests, take measurements

- **Difficulties:**
  - Design, fabrication and installation of a micro-sensor
Context

Data gathering—to obtain data that will enable a hypothesis test.
Example proof of a conjecture and research plan

• Example conjecture: A bi-tangential transfer between coplanar orbits is globally optimal

• Research plan:
  – Apply Green’s Theorem to reduce the dimensionality of the problem to 2 dimensions
  – Exhaustively consider all possible classes of geometries

• Difficulties:
  – Framing the coordinate system to enable consideration of all possible cases
Context

Mathematics—to broaden our capability of thinking logically (in a self-consistent manner).
Example transfer of knowledge from one field to another

- Example application of knowledge from one field to another: *Apply Arrow’s Impossibility Theorem (AIT) to determine the mathematical rigor of multi-scale modeling as applied to chemical-mechanical polishing (CMP)*

- Research plan:
  - Extend AIT to engineering decision making
  - Apply this extension to the case of CMP

- Result (this was a funded study):
  - Multi-scale modeling is not mathematically valid
  - Dark matter is a ghost
Context

Mathematics—to discover and resolve inconsistencies across disciplinary boundaries and broaden our ability to think consistently.
Tasks follow from objectives

• For a hypothesis:
  – Develop a mathematical model
  – Gather experimental data
  – Compare model results to data

• For a measurement:
  – Design the measurement
  – Procure necessary equipment
  – Perform measurement procedures
Important concept

The reviewers read your proposal, not your mind
Exercise

• Write high-level tasks to apply a theory from one field to solve a problem in another field
  – Examples:
    • Use of wavelets
    • Multi-scale modeling
    • Application of decision theory
    • Use of Monte Carlo analysis
Summary page

- Importance: it’s the page people actually read
- It’s the page that reviewers and Congressional aides read
- It must convey:
  - The objective
  - The approach
  - The motivation:
    - Intellectual merit
    - Broader impact
Writing the summary

• The most important statement is the statement of your proposed objectives
  – It should be at the very beginning
  – Do not begin with a weather report: “The sky is falling. Tools are breaking. Designs are failing…”
  – Do not begin with a state-of-the-union address: “The U.S. lags in the development of a strong manufacturing base…”

• Remember, this is not a tech paper, it is not a murder mystery (where we find out what the objective is on page 15)

• Intellectual Merit and Broader Impacts statements (and, for CAREER, educational plan) are important
Summary template

• Overview
  – The research objective of this proposal is... The research approach is...

• Intellectual Merit
  – The contribution of this research to the field of engineering is...

• Broader Impacts
  – The value of this research to society at large is...
IM and BI Statements

• They are required in both the summary and the project description
• Your proposal will be rated based on them
• But:
  – What are they?
  – What should you include?
  – How should they shape your proposal?
Intellectual Merit

• The Intellectual Merit is the potential that your research has to advance the knowledge base of the field of science or engineering

• Questions:
  – What is already known?
  – What is new?
  – What will your research add?
  – What will this do to enhance or enable research in your or other fields?

• Why is your research important for the advancement of your field?
Intellectual Merit

• It’s all about science and engineering
• It’s technical
• Ordinary people wouldn’t care
• How does your research advance the field?
  – Resolving contradictions/paradoxes
  – Adding rigor
  – Validating a theory
  – Enabling additional research
Broader Impacts

• The Broader Impacts focuses on the potential benefit to society and achievement of desired societal outcomes

• Means to benefit society include:
  – Economic/environment/energy
  – Education and training
  – Providing opportunities for underrepresented groups
  – Improving research and education infrastructure

The key issue is how your research results will be applied — why would the general public care?
Typical impacts

- More money
- Lower taxes
- Better health
- Job creation
- Safety and security
- Economic opportunity
- Equality
- Better education
- Improved communication
- Safer food/water
- Higher reliability
  - Electric power
  - Water
- Cleaner environment
Be careful to keep the parts separated correctly. Read each sentence of your summary independently and be sure each sentence says something relevant to your proposed work and is in the correct section.
Overview - The research objective of this proposal is to test the hypothesis that the propensity of a tree to break is directly proportional to how many monkeys are in the tree. The approach will be to take a sample of ten trees and load them with monkeys until they break...

Intellectual Merit – It is important that we know how many monkeys can climb a tree before it breaks because this affects our perceptions of monkey procreation and... The Snerd Theory holds that tree size limits monkey procreation. This study challenges that theory with the notion that... If the objective hypothesis is correct therefore, it will transform our approach to...

Broader Impacts – Monkeys are used in medical research. By knowing how many monkeys can fit in a tree, we will be able to provide more monkeys for such research thereby advancing medical science more quickly and improving the quality of life. Also, by watching the monkeys get hurt when the tree breaks, graduate students will be less likely to climb trees, thereby increasing their probability of graduating.
The focus of the summary

- Keep the focus on things that the reviewers don’t know
- Minimize verbiage about things that the reviewers already know or can find easily
- Remember, there are things that reviewers can learn only from you:
  - What you want to do
  - How you want to do it
The rest of your proposal

• The project description
  – Limited to 15 pages
  – Begin with a restatement of goals and objectives
  – Provide motivation
  – Frame your research around the prior work of others
  – Describe tasks
  – Include mandatory sections (IM, BI and results from prior NSF support)
Literature search

• You must know the state-of-the-art

• Literature:
  – It existed before 1993
  – It is not up to date
  – >50% of it is bogus—how do you deal with this?
Other sources

- Site visits to top researchers
- Conferences
- Survey papers
- Workshops and workshop reports
- NAS/NAE studies
Preliminary results

• Are they necessary?
• Why do they help:
  – Evidence of validity of an hypothesis
  – Evidence that you can do the proposed work
  – Enable better understanding
  – Validate the proposed approach
• Should NEVER be used to help clarify the research objective
Arguing that you can do the proposed research

- Your bio
- Your publications
- Your facilities
- Your collaborators
- Previous results
- Other support
Arguing that your proposed research is worth doing

• Intellectual merit—the contribution of your research to the field of engineering or science
• Broader impacts—the value of your research to society at large
Other parts

• Bios
• Budgets
• Post doc mentoring plan
• Letters of collaboration
• Data management plan
• Anything else specifically required by a solicitation
Do

• Have a strategic plan
• Build on your strengths
• Differentiate this proposal from your Ph.D. thesis work and other sponsored work
• Perform a thorough literature search (and in some cases exploratory research) before writing the proposal
  – Journal articles (update with personal contacts)
• Read the NSF PAPPG
• Establish and keep your contacts
Do not

• Rush
• Wait until last minute (1 month) to contact a program director
• Make the proposed work (research and education) too broad
• Make the proposed work too narrow
• Ask for too much (or too little) money
• Ignore rules (PAPPG)
• Try to submit your proposal late
Exercise

• Which of the following are IM and which are BI?
  – Understanding the spalling process will enable better bearing design
  – Creating a valid theory of engineering design will enable cost savings in government procurements
  – Measurements of cutting surface temperature will enable the development of predictive models for cutting processes
  – Understanding the effect of fiber variability on delamination of composites will enable the manufacture of more reliable components
Research ethics

• Persons submitting proposals to the Federal government are held to high standards of conduct
• Misbehavior can be dealt with quite severely
  – PI may be barred from submission to NSF for 1-5 years
  – May be barred from proposal review
  – At least two cases of jail time (Grimes case, 41 months in Federal prison)
  – Maximum $250,000 fine, 5 years in prison
Major forms of misconduct

• Plagiarism—uncited reproduction of the work of others
• Falsification—intentional misrepresentation of data or results (progress reports)
• Fabrication—making up data
• Double charges—billing the government twice for the same work, e.g., accepting funding from two different Federal agencies for the same work
Plagiarism

OIG recommends NSF suspend award CMMI-_______ (the proposal), “_______,” under the direction of Principal Investigator (PI) Dr. ____. The $1,000,000.00 grant was awarded to University effective ____, 2011, and expires ____, 2013. It was Dr. ____’s first award from NSF. Dr. ____ also has submitted a CAREER proposal which is pending (CBET-______). OIG is currently investigating an allegation that Dr. ____ plagiarized over 200 lines of text, 1 figure, and 42 embedded references into her proposal.

THIS IS A POTENTIAL FELONY!!!
Charging twice for the same work

- *Chemical & Engineering News*, Feb. 13, 2012—Federal prosecutors have charged a leading materials scientist with wire fraud, making false statements, and money laundering. The researcher, Craig A. Grimes, formerly an electrical engineering professor at Pennsylvania State University, defrauded federal agencies of some $3 million in research grants, the prosecutors say… Prosecutors also say Grimes applied for and accepted an ARPA-E grant for his solar work, while failing to disclose that the National Science Foundation had already funded the same research. Both agencies prohibit such grant duplication.

- Grimes was sentenced to 41 months in Federal prison and $660,000 in repayments
Inappropriate use of grant funds

– Padding travel
– Commingling funds
  • Don’t mix business and pleasure expenses
  • Don’t mix grant funds and personal business expenses
– Charging for time not spent on a grant
– Billing items to your grant that shouldn’t be billed to the grant
– Billing alcohol or entertainment to a grant
– Charging give-aways to a grant
Inappropriate use of funds

States News Service, August 29, 2014

Morgan State University Professor Sentenced To 3 Years In Prison In Scheme To Defraud The National Science Foundation And For Obtaining Kickbacks From Student Stipends

Fraudulently Obtained $200,000 and Attempted to Obtain Another $500,000 through a National Science Foundation Small Business Program

FOR IMMEDIATE RELEASE
August 29, 2014

Baltimore, Maryland - U.S. District Judge Ellen L. Hollander sentenced Manoj Kumar Jha, age 47, of Severn, Maryland, today to three years in prison followed by three years of supervised release for wire fraud, mail fraud, falsification of records, and theft of government property in connection with a scheme to fraudulently obtain research grants from the National Science Foundation (NSF) and kickbacks from students’ stipends. Judge Hollander also entered an order requiring Jha to pay $105,726 in restitution.
Train and verify

• Faculty and students should be trained—consequences should be made explicit
• Institutions need to perform oversight
• Institutions themselves need to operate in a culture of compliance
Confidentiality for panelists

• Breach of confidentiality—never divulge confidential information (NSF Form 1230P)
  – Ideas conveyed in proposals
  – Names of panelists
  – Names of PIs
  – Never use information that you received in confidence

Plagiarism is bad, plagiarism from a proposal you reviewed is a breach of confidence—much worse
Letters of support

• It is generally against the law for an employee of the Federal Government to represent a third party to the Government

• Persons working at NSF may not write letters advocating awards for specific PIs
Multiple proposal submissions

• It is permissible to submit multiple proposals to do the same thing to different Federal agencies
  – But it is not permissible to submit the same proposal to multiple NSF units
• It is not acceptable to accept more than one
• If you submit multiple proposals for the same or similar work, be careful to distinguish the uniqueness of each and, if appropriate, accept funding only once
Falsification and fabrication

Falsified or fabricated annual reports may constitute a felony

Remember, Al Capone went to jail for lying, not for murder
Research ethics training

• As of January 4, 2010:
  – Certification Regarding Responsible Conduct of Research (RCR): The AOR is required to complete a certification that the institution has a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students, and postdoctoral researchers who will be supported by NSF to conduct research.
Sticky issue

• Suppose you collaborate with another faculty member, write a proposal and get an award, then later find that your collaborator plagiarized materials that are in the proposal

• You should
  – Consult with your institutional ethics person
  – Report the matter to the NSF Inspector General
  – Continue to work on the grant

• You generally will not be held accountable for another faculty member’s bad behavior
References

• Responsible Conduct of Research (RCR)

• Research Misconduct
Misconduct—a recent case

A former Iowa State University professor has pleaded guilty to two felony counts of making false statements to the National Science Foundation, federal prosecutors announced Tuesday. Palaniappa Molian, of Ames, pleaded guilty Friday to the charges in a written plea agreement with federal prosecutors in the U.S. Attorney’s Office for the Southern District of Iowa.

ISU officials confirmed Tuesday that Molian was a professor in the College of Engineering beginning in 1982, and retired on Dec. 31, 2013. In December 2009, “Molian claimed in a requested reimbursement that he traveled to Boston, Mass., to work on an Iowa State University National Science Foundation grant research experiment,” according to a press release issued Tuesday by the U.S. Attorney’s Office for the Southern District of Iowa.

Molian admitted in the plea agreement that “he did not perform any work on the grant research experiment in Boston, and that he traveled to Boston for unrelated reasons,” the press release said.

The reimbursement expense voucher Molian filed for the trip to Boston was for $1,223.37, court documents that were unsealed Friday show. Molian also pleaded guilty to submitting a Small Business Innovation Research Program Report to the NSF in July 2010, seeking approximately $20,000 in laser rental costs, “when he had access to a laser at no cost,” the press release said.

“The laser costs claimed in the Final Report were false and (Molian) spent the excess grant funds on unrelated personal expenses,” court documents show.

As part of the plea agreement, federal prosecutors agreed Molian will not be charged in the Southern District of Iowa for any other federal criminal offenses arising from or related to the investigation.

Exceptions to this agreement would be “any criminal act occurring after the date of this agreement, any crime of violence, or any criminal offense which (Molian) did not fully disclose to law enforcement during (Molian’s) interviews,” court documents show.

The plea agreement also states that Molian and the prosecutors “agree to recommend a sentence of probation,” but if a judge doesn’t impose the recommended sentence, either party can withdraw from the plea agreement, and the case will be set for trial.

Molian has agreed to pay restitution “for all relevant conduct,” according to the terms of the plea agreement. The amount of restitution will be determined by a judge.

Molian will also be required to pay a mandatory special assessment fee of $200 at or before sentencing. The maximum sentence for making a false statement to a federal agency is five years imprisonment and a maximum fine of $250,000.

Molian was required to turn over his two passports to probation officers, and was released from custody on promise to appear, court documents show. He will be sentenced April 25 at the U.S. Courthouse in Des Moines by Chief U.S. District Court Judge James E. Gritzner.
Parting thoughts

Remember, if your grad student writes your proposals, you are responsible for their content, and you are the person in trouble if there is a breach of ethics.

You have worked hard to establish your career, don’t ruin it by a breach of ethics.
12 Steps to a better proposal

1. Know yourself - strengths/weaknesses
2. Know the program from which you seek support
3. Read the program announcement and PAPPG
4. Formulate clear and appropriate research and outreach objectives
5. Develop a viable plan to accomplish your stated objectives
6. State your objectives up front in your proposal
12 Steps to a better proposal (cont’d)

7. Frame your project around the work of others
8. Grammar and spelling count
9. Format and brevity are important
10. Know the review process
11. Proof read the proposal before you submit it
12. Submit your proposal early and proofread it after you submit it