Academic Mentoring Workshop

Writing Competitive Research Proposals

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First Principles

- Get to know the agency's programs in your area
  - Lay of the land
- Review program "summary of awards"
  - Past trajectory
- Get to know your program officer(s)
  - Current trajectory
- Participate in agency-sponsored workshops
  - Help set future trajectories
- Serve on review panels and as an ad hoc reviewer
  - Exposure to lots of proposals
  - Exposure to many proposal evaluators
- Stay informed
  - NSF email updates: Daily Digest Bulletin
- Develop good proposal-writing habits

Adapted from Bryant York, PSU

Types of Proposals

- Research
  - Single-investigator
  - Multi-investigator
- Research Infrastructure
- Education
  - Curriculum Development and Innovation
  - Training and Advancement
- Special Opportunities
  - NSF RAPID, EAGER, FASED, Travel, Workshops, GRFs, Postdoctoral Fellowships, Faculty Fellowships (industry or foundations), Special Projects, etc.
- Supplements – standard, REU, RET, ROA
- SBIR, STTR

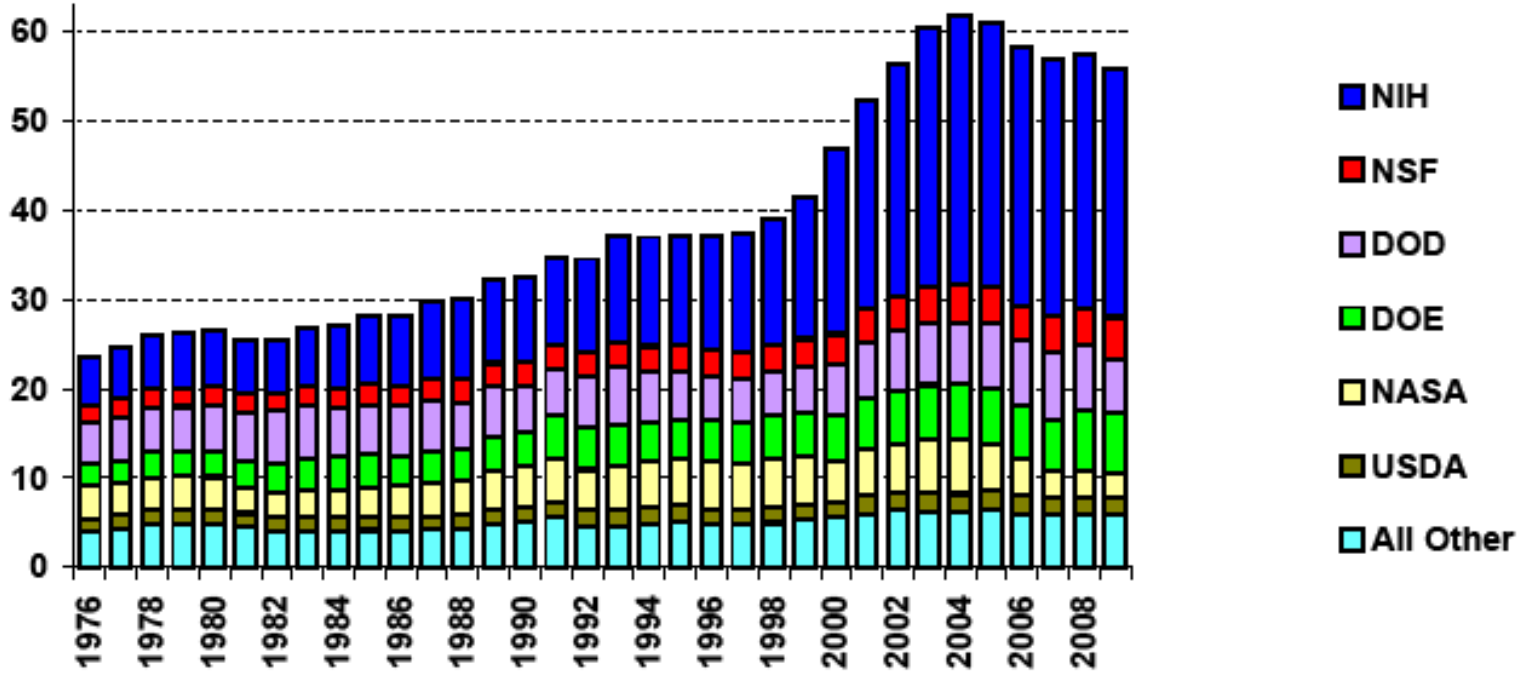
Adapted from Bryant York, PSU

Outline

- ✓ First Principles and Types of Proposals
- Funding Agency Information: NSF
- Research Proposal Preparation
- Tips for Writing Competitive Proposals

Trends in Research by Agency, FY 1976-2009 *

in billions of constant FY 2008 dollars



Source: AAAS analyses of R&D in annual AAAS R&D reports.
* FY 2009 figures are latest AAAS estimates of FY 2009 request. Research includes basic research and applied research. 1976-1994 figures are NSF data on obligations in the Federal Funds survey.
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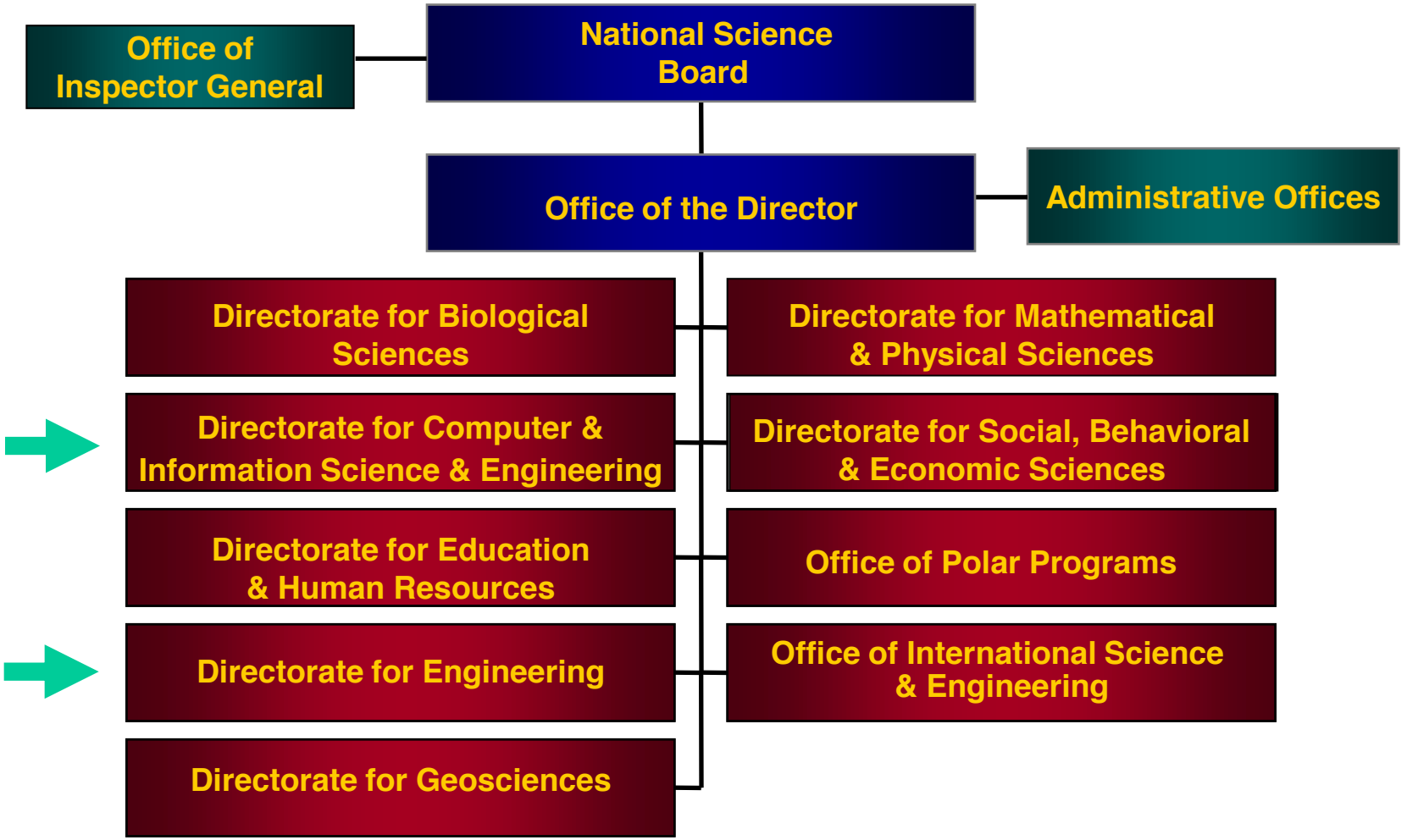
2009 DOD does not show adds Congress will insert in the appropriations bill

AAAS

National Science Foundation

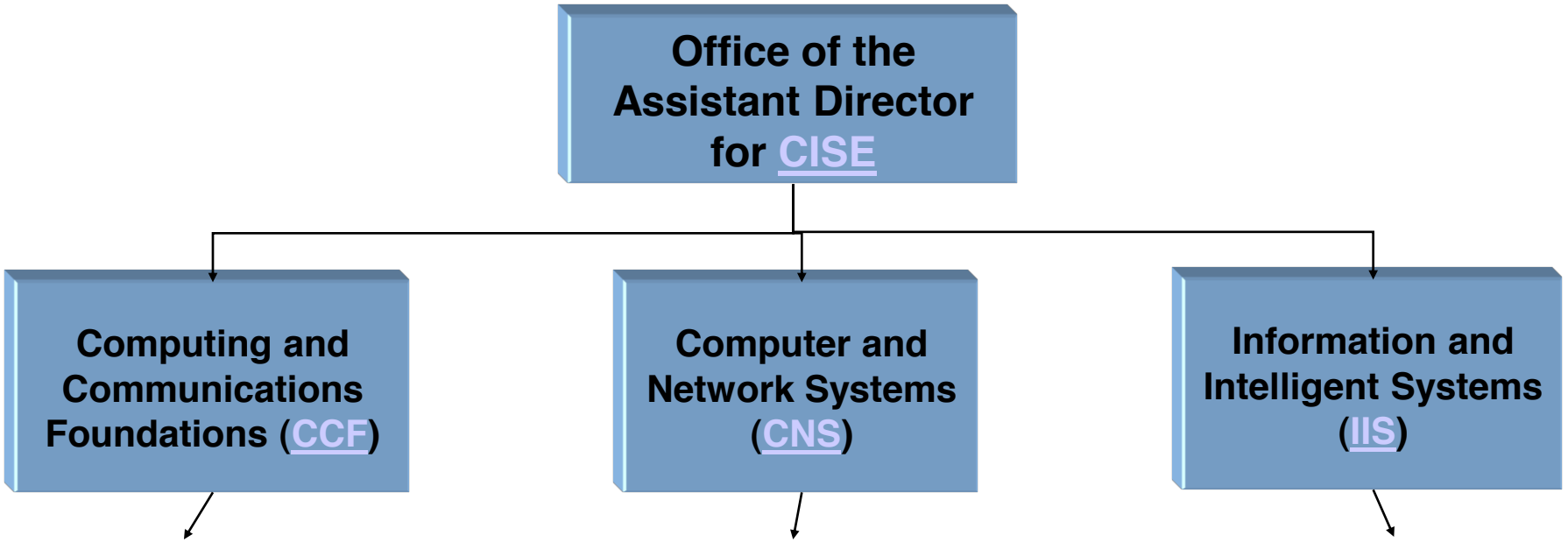


NSF Budget Request: *www.nsf.gov/pubs/2013/nsf13019/nsf13019.pdf?WT.mc_id=USNSF_179*

NSF '14 budget request: *$7.625 billion* (>7.7% over enacted '13 level)

CISE 2014 budget request: *$950 million* (~10% increase over '13)

NSF CISE Directorate



- Algorithmic Foundations (AF)
- Communications and Information Foundations (CIF)
- Software, Hardware Foundations (SHF)

- Computer System Research (CSR)
- Networking Technology and Systems (NeTS)

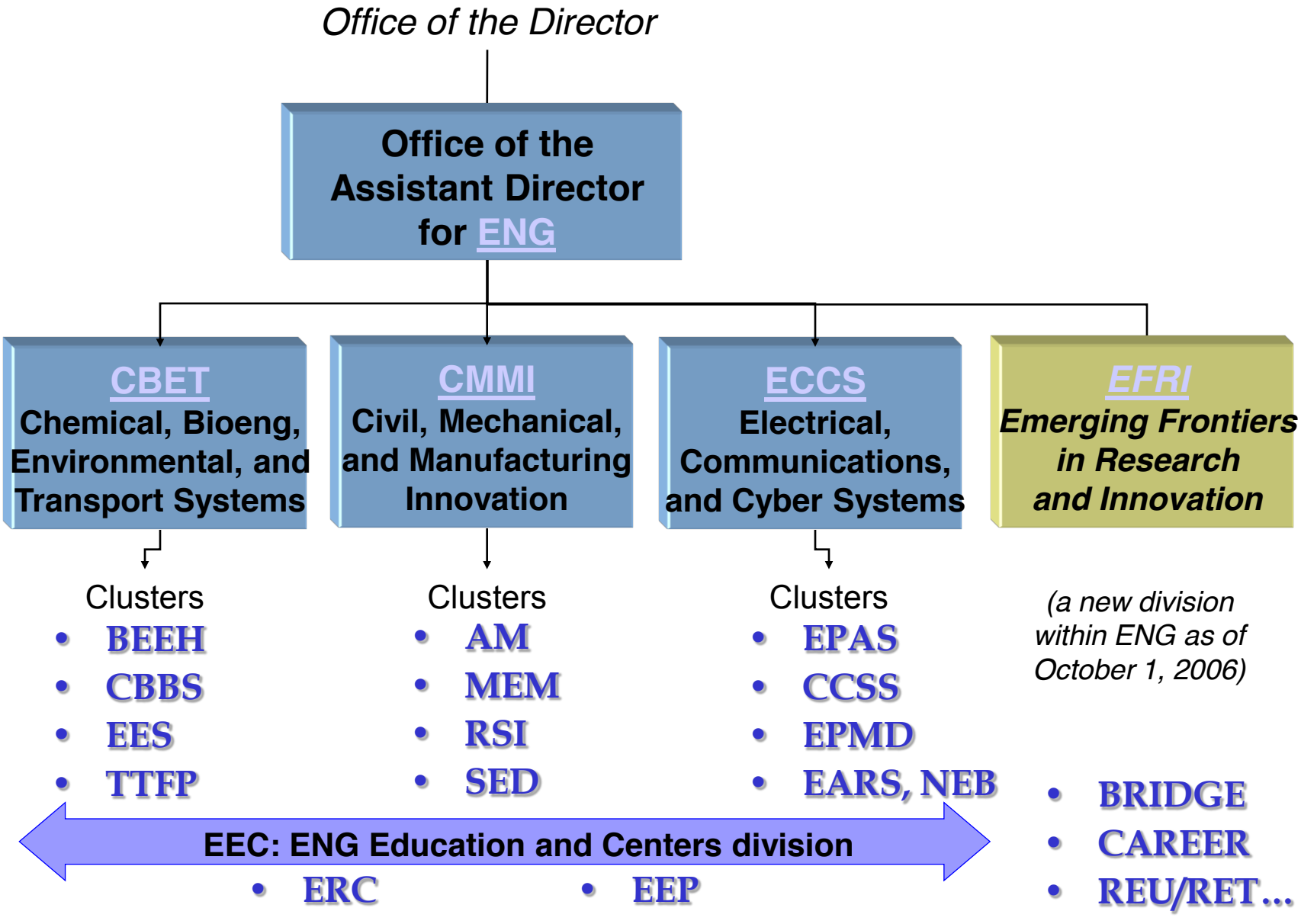
- Human-Centered Computing (HCC)
- Information Integration and Informatics (III)
- Robust Intelligence (RI)

❖ **Division of Advanced Cyberinfrastructure**

Crosscutting CISE, NSF Emphasis Areas

• EiC	• XPS	• NRI, CE21	• CAREER
• I-Corps	• SaTC	• CRI, MRI	• CDI, ADVANCE
• CPS	• SCH	• REU, RET	• IGERT, GK-12

NSF ENG Directorate



Outline

- ✓ First Principles and Types of Proposals
- ✓ Funding Agency Information: NSF
- Research Proposal Preparation
  (some slides adapted from NSF)
- Tips for Writing Competitive Proposals

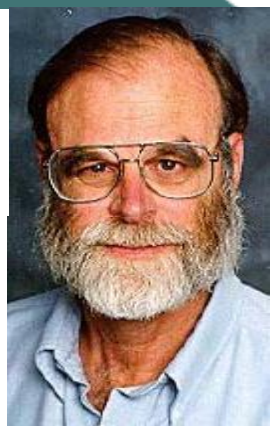
Research

Research **is a wonderful process of inquiry and discovery for making advancements on critical societal challenges**

Research Proposals

A *fundable proposal* describes a good idea and attainable goal, well expressed and motivated, with a clear indication of methods for pursuing the idea, evaluating the findings, making them known and having broad impact.

Properties of a Research Goal

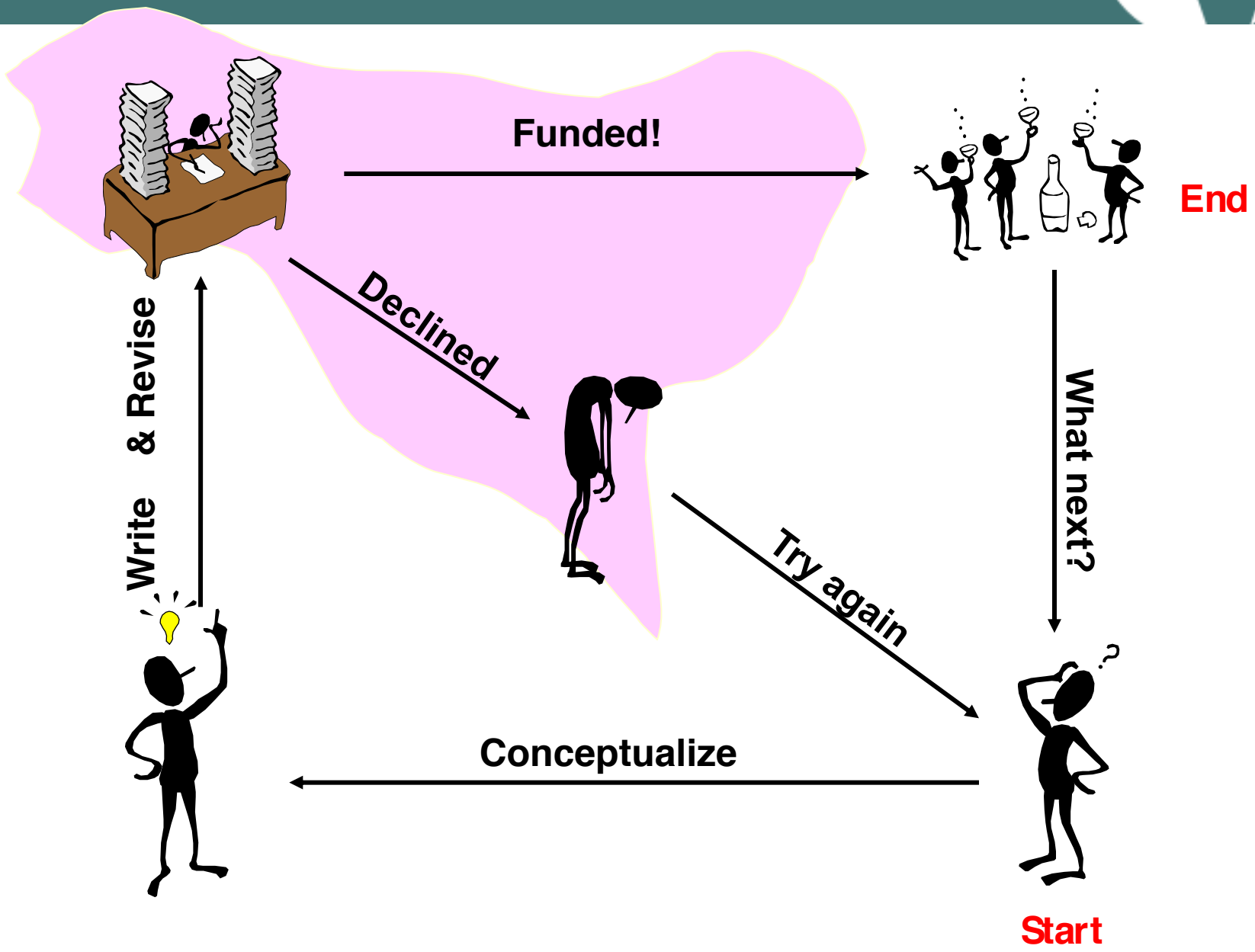


- Simple to state
- Not obvious how to do it
- Clear benefit
- Progress and solution are testable
- Can be broken into smaller steps
  - So that you can see intermediate progress

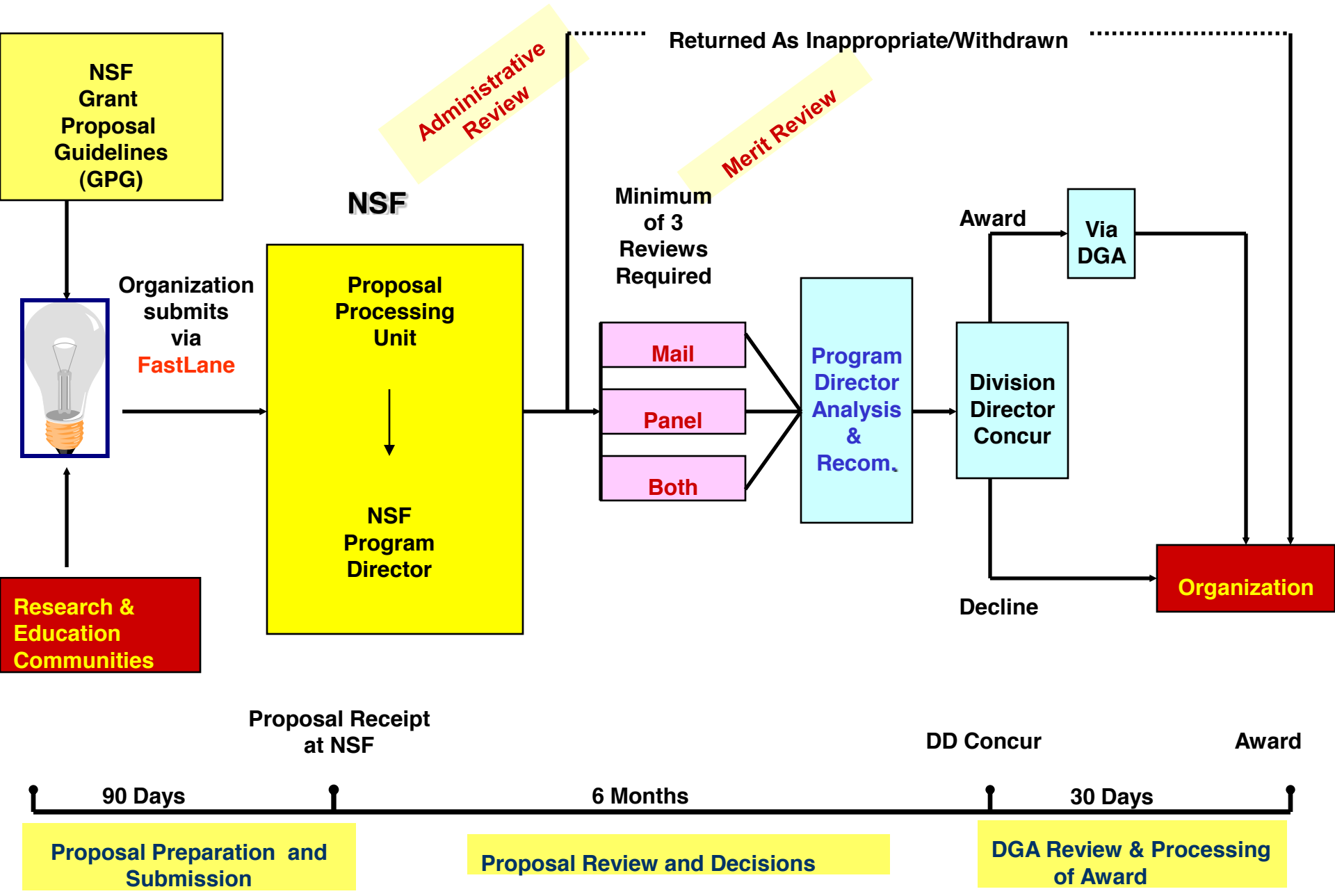
By Jim Gray, Turing Award Winner

http://research.Microsoft.com/~Gray/talks/Turing2.ppt

Proposal Life Cycle



NSF Proposal Review and Award Process & Timeline

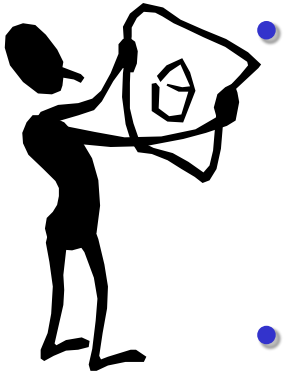


Proposal Submission Preliminaries

- **Who can submit NSF proposals?**
  - Universities and colleges
  - Non-profit, non-academic organizations
  - For-profit organizations
  - State and local governments
- **What to submit?**
  - Letter of Intent, Preliminary Proposal, Full Proposal
- **When to submit?**
  - Target date, deadline, and submission window
- **Where to submit proposals?**
  - FastLane (https://www.fastlane.nsf.gov)
  - Grants.gov (http://www.grants.gov)

- **Why submit?**
  - Enables the advancement of research and education
- **How to know about funding opportunities?**
  - Program Descriptions, Program Announcements, Dear Colleague Letters, and Program Solicitations
  - via NSF email updates or NSF website (other distribution lists)

Step 1: Carefully Read the Program Descriptions and Solicitations



- **Find the right program early!**
  - It's better to do this well before you write than after you get your reviews back
- **Talk with your Program Director to make sure your ideas fit in the program**
  - If the Program Director (PD) tells you that your ideas are too narrow or don't fit the program, look for other sources
- **Make sure your project is worthwhile, realistic, well-planned, and innovative**

Step 2: Develop Your Good Idea

- **Key Questions**
  - What do you intend to do and how will you do it?
  - Why is it important?
  - What does the literature provide?
- **Make sure the idea is innovative and exciting**
  - Survey the literature
  - Talk with others in the field
- **Convince people you can accomplish it**
  - Obtain preliminary data to support feasibility
  - Determine available facilities and resources
    - What infrastructure do you have to work with?
    - With whom will you work (students, collaborators, industry partners)?

Step 3: Prepare the Submission

NSF Grant Proposal Guide (GPG)

http://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/gpg_index.jsp

- **Preparation and submission instructions**
  - Proposal format and contents
  - collaborative proposals from multiple institutions
    - One submission with "sub-awards" from lead institution
    - Separate simultaneous proposal submissions (FastLane)
  - Return without review criteria
- **Review criteria and review process**
  - Withdrawal
  - Invite/Not-Invite, Encourage/Not-Encourage
  - Award/Declination
- **Post Award Processes**

NSF Proposal Contents

- Cover Sheet and Certifications
- Project Summary (*one page max*)
- Table of Contents
- Project Description (*typically 15 pages max.)*
- References cited
- Biographical Sketches (*2 pages/Senior Investigator*)
- Budget and Budget Justification (*3 pages max.*)
- Current and Pending Support (*all sources*)
- Facilities, Equipment and Other Resources
- Supplemental Documentation
  - all proposals must include ***Data Management Plan***
  - support for postdocs require ***Postdoc Mentoring Plan*** (1 page)
  - add'l allowed docs may vary by programs and directorates
- Single Copy Documents
  - Reviewer suggestions, confidential information, etc.

Project Summary

- **This one page summary is critical**
  - Not an abstract; a self-contained description of the activity
  - May affect which program or panel will review your proposal
  - Must address both *Intellectual Merit* and *Broader Impacts*
- **Written in third person**
- **Intellectual Merit**
  - Describe the scientific/engineering problem and its importance
  - State the overall objective and specific aims of the project
  - Describe how the objectives and aims will be achieved
- **Broader Impacts**
  - Educational & outreach activities; infrastructure; dissemination of results; underrepresented groups; benefits to society
  - See http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf

NSF Proposal Merit Review Criteria

The *Intellectual Merit* of the proposed activity

- **Creativity, originality, *and potentially transformative***
- **Potential to advancing knowledge and understanding within and across fields**
- **Conceptualization and organization**
- **Qualifications of investigators**
- **Access to resources**

Funding Criteria: Intellectual Merit

- *Objectives, method/approach, potential impact compelling?*
- How ***important*** is the activity to *advancing knowledge and understanding* within the field or across different fields?
  - ***Significance*** *of expected results*: incremental? high impact? high-risk but high-gain?
- How well ***qualified*** are you to conduct the research?
  - Not necessary to have track record on specific topic, but ***quality*** *of prior work* usually a consideration, as are ***preliminary results***
- How creative, ***original*** are the concepts and ideas?
  - Should be ***ground-breaking*** in some aspect
- How well conceived, ***organized*** is the proposed activity?
  - *Well-articulated* ***problem*** and *well-structured research* ***plan***
- Is there sufficient *access to* ***resources***?
  - Ownership is not necessary, only ***access*** to equipment, facilities, human capital, …

NSF Proposal Merit Review Criteria

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  - Creativity, originality, ***and potentially transformative***
  - Potential to advancing knowledge and understanding within and across fields
  - Conceptualization and organization
  - Qualifications of investigators
  - Access to resources
- The ***Broader Impacts*** of the proposed activity
  - Discovery while promoting teaching, training and learning
  - Participation of underrepresented groups
  - Enhancement of infrastructure for research and education
  - Dissemination of results to enhance scientific and technological understanding
  - Benefits to society

Funding Criteria: Broader Impacts

- Does the activity advance discovery and understanding while *promoting teaching, training and learning*?
- Does the activity *broaden the participation* of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?
- Will it *enhance the infrastructure for research and education*, such as facilities, instrumentation, networks and partnerships?
- Will the *results* be *disseminated broadly* to enhance scientific and technological understanding?
- What may be the *benefits* of the proposed activity *to other disciplines and society* as a whole?

(See *www.nsf.gov/pubs/gpg/broaderimpacts.pdf*)

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  - Discovery while promoting teaching, training and learning
  - Participation of underrepresented groups
  - Enhancement of infrastructure for research and education
  - Dissemination of results to enhance scientific and technological understanding
  - Benefits to society
- Program-specific merit review criteria
  - Some programs have additional review criteria in solicitation
- There are NSF general statements regarding intellectual merit and broader impact, but also some programs list examples of these criteria specific to the program
  - See *http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf*

Project Description

- Max. 15 pages (preliminary proposals fewer)
- Objectives and expected significance
- Relation to present state of knowledge
- General plan of work
- Experimental methods and procedures
- Broader impacts
- Results from prior agency-sponsored support
  - required, if applicable (5 pages max., typically fewer)
- (Optional: relation to your longer term goals)
- URLs not to be used; unlimited references--add'l pages
- Unbudgeted substantial collaborations documented
  - letters of commitment in supplementary documents

Project Description (Possible Outline)

- Introduction (~2 pages)
- Related Work and Research Scope (~2-3 pages)
- Proposed Research (~5-6 pages)
- Research Plan (~2 pages)
  - How proposed techniques will be evaluated
  - Experimental set-up/tools/methods
  - Timeline of major milestones (by year)
- Broader Impact (~1-2 pages)
  - Research Community/Industry
  - Education
  - Outreach to broaden participation
- Results from Prior NSF Support (~1 page)
- References (unlimited pages, but typically < 6 pages)

Project Description

- **Tip: Know your audience – reviewers, PD!**
  - Write accurately, concisely, and clearly
  - Make it easy for reviewers to like your proposal
  - First few pages engage or lose the reviewer
  - Figures and tables help get points across clearly
  - Some reviewers (particularly on interdisciplinary proposals) may not be experts in your specific field

Biographical Sketch

- Limited to only two pages—prescribed format
- Professional preparation
  - degrees, postdoc(s)
- Appointments
  - reverse chronological order
- Publications—submitted, accepted, appear
  - up to 5 closely related
  - up to 5 other significant publications
- Synergistic activities
  - up to 5 examples that demonstrate broader impact, service
- Collaborators & other affiliations (for COIs)
  - collaborators, co-authors (last 4 yrs) & co-editors (last 2yrs)
  - graduate and postdoctoral advisors
  - thesis and postgraduate-scholar (past 5 years) advisees

Budget

- **Budget should be**
  - for each year of support requested
  - reasonable, but request what is needed
  - for personnel, equipment (>$5K), travel, participant support and other direct costs (sub-awards, consultants, materials & supplies publication costs)
  - for cost of educational activities associated with research, where appropriate
- **A separate budget needed for each sub-awardee**
- **No NSF expectation of cost sharing component**
- **Budget must be accompanied by Budget Justification for direct cost line items (3 pages max.)**
  - 2 months salary maximum in any one year
  - admin staff salaries counted in indirect cost (few exceptions)
  - list only number of grad and undergrad students in budget

Current and Pending Support

- List all current and pending support, including the proposal being submitted
  - Fed, state, local, foreign, industrial, private
  - all funded activities requiring a portion of your time
- Be careful of overlap
  - perceived overlap could be detrimental in review
  - same work not to be funded twice!
- Concurrent submissions of same proposal (not BIO)
  - allowed to multiple programs (bad idea); agencies OK
  - must withdraw proposal if gets funded elsewhere
- Resubmission of prior proposals
  - if funded before, must include last period in current/pending list
  - if declined before, must be revised substantially for resubmission; otherwise can be returned without review

Supplementary Documentation

All materials included in merit review (seen by reviewers)

- **Data Management Plan (2 pages max.)**
  - required of ***all*** proposals (can say "no plan needed")
  - must conform to dissemination/sharing policy
- **Postdoctoral Researcher Mentoring Plan (1 page max.)**
  - required if postdoc support is requested
  - description of mentoring activities
  - included in merit review
- **Program-specific Management Plans**
  - typically for large and center-scale proposals
- **Letters of Commitment**
  - unbudgeted collaborations of significance
  - "letters of support" endorsements not to be included

Outline

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  (some slides adapted from NSF)

Access Available Help

- **Proposal Writing Workshops and Resources:**
  - http://www.cis.temple.edu/NSFCareer2013 (March 15, 2013, Temple University, Philadelphia)
  - http://www.clarku.edu/offices/research/pdfs/NSFProposalWritingTips.pdf
- **Read:**
  - Sponsoring agency publications
  - Successful proposals
- **Look before you leap:**
  - Serve as a proposal reviewer and panelist
- **Talk with people in-the-know:**
  - Current and former Program Directors
  - Successful colleagues, mentors, reviewers

Access Other Sources

- **Agency Publications**
  - Program Solicitations
  - Grant Proposal Guide
  - Web Pages
  - Funded Project Abstracts
  - Reports, Special Publications
- **Program Directors**
  - Incumbents
  - Former “Rotators”, “IPAs”
- **Mentors on Campus**
- **Previous Panelists**
- **Sponsored Research Office**
- **Successful Proposals**

Be Reasonable

- **Start early and get feedback**
  - Write, rewrite, and rewrite again…
- **Be aware of the research scope:**
  - "Too ambitious" vs. "Too narrow"
- **Be honest and up-front:**
  - Address issues instead of trying to hide them
  - Acknowledge possible experimental problems and have alternatives

Make It Easy for Reviewers

- **Know your audience:**
  - All reviewers may not be experts in your specific field
- **Simplify and streamline:**
  - Make sure you get your main idea(s) across
- **Pay attention to details:**
  - Run the spell checker and proof-read
  - Prepare clear photos, graphs, etc.
  - Make the font size as big as you can (minimum of 6 lines per inch with 1” page margins!)

Basis for Decisions: Reviewer Input

- **Reviews**
  - Content/justification of the reviews by reviewers oftentimes is more important than just the rating
- **Panel Ranking**
  - Proposals (competitive ones) often ranked by panel
- **Program Director uses reviews and panel summary/recommendation in award decisions**
  - Fairness
  - How substantive the reviews are
  - Technical problems raised in the reviews
    - major vs. minor issues
  - Reasons for the reviewer concerns or enthusiasm

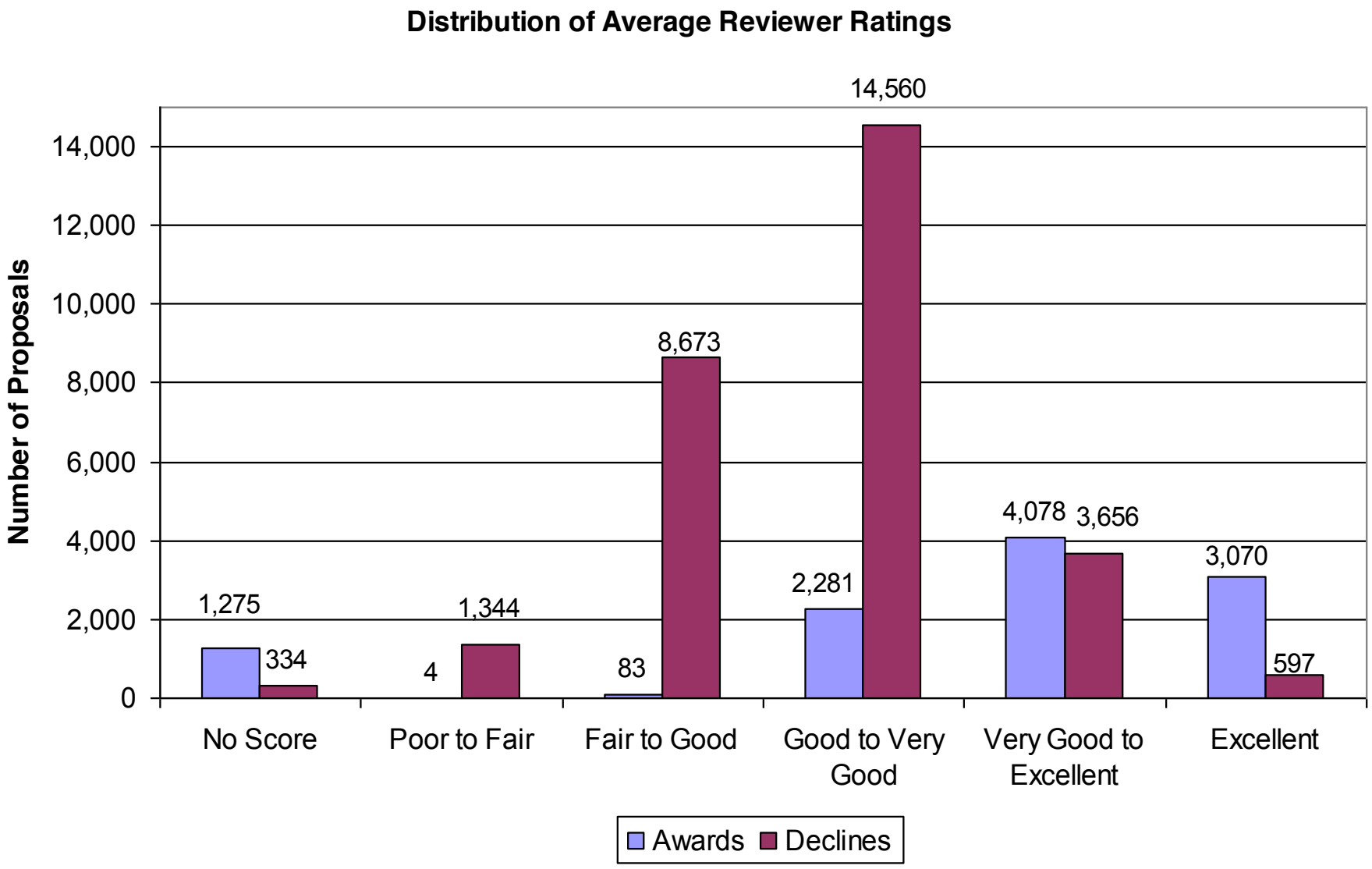
Evaluation: Ad Hoc and Panel Reviews

- A *minimum of 3 reviews/proposal* (typically 4 or more)
  - A *score* of *E*, *V*, *G*, *F*, *P* is given by each reviewer
  - *Comments* on intellectual merit and broader impacts
  - Typically, a *recommendation* to fund (or not) is given
- Panel Review:
  - Proposals are discussed and *evaluated collectively*
  - *Proposal summary* is written—couple of sentences
  - Intellectual merits are described: *strengths, weaknesses*
  - Broader impacts are described: *strengths, weaknesses*
  - *Improvements* may be suggested (optional)
  - *Panel recommendation*: *Highly Competitive (HC), Competitive (C), Low Competitive (LC), Not Competitive (NC)*
- *Comments are intended to help* unsuccessful PIs improve their proposals for the next competition

Basis for Decisions: Balanced Portfolio

- **Program Director uses other information in addition to reviewer input in making decisions**
  - Innovation and creativity
    - High risk, high reward projects
  - Breadth of research areas
  - Priority areas and systems
  - Demographics, diversity along many dimensions
    - Broadening participation
    - Institutional impact: EPSCOR, MSI, PUI, etc.
    - International collaborations
  - Integration of research & education

NSF Proposal Review Ratings



Number of FY'03 Proposals: 29,164 Declines, 10,791 Awards (37% success)

Why Do Some Proposals Fail?

- **Absence of innovative ideas**
  - At best, provides only incremental advances
  - Not exciting or cutting edge
  - "just another proposal about"
- **Errors**
  - Unclear or incomplete expression of aims
  - Faulty logic or experimental design
  - Less than rigorous presentation
- **Unrealistic, sloppy or incomplete**
- **Resources and facilities not in place**
  - PI qualifications/expertise not evident
  - Necessary collaborations not documented

Seven Deadly Sins of Proposal Writing

1. Failure to focus on the key problems and payoffs
2. No persuasive structure: *poorly organized*
3. No clear differentiation: *competitive analysis*
4. Failure to offer a compelling value proposition: *potential impact*
5. Key points are buried: *no highlights, impact is lost*
6. Difficult to read or appreciate: *full of jargon, too many low-level technical details or not enough details*
7. Credibility killers: *misspellings, grammatical errors, wrong technical terms, inconsistent format, …*

Closing Remarks

- There may be no *"best"* (or only) way to write a competitive research proposal, but many successful ones share similar characteristics
  - *clearly written, well motivated, organized, original, targeted, important, accomplishable, impactful, significant*
- *Funding depends* on many things, some of which are beyond your control
  - availability of funds, portfolio of existing funded research projects, set of reviewers, timing, …
- Be persistent and give your *best effort; success will come!*

Useful NSF On-line Documents

- FY 2014 NSF Budget Request
  - http://www.nsf.gov/about/budget/fy2014
- FY 2012 NSF Budget
  - http://www.nsf.gov/about/budget/fy2012
- Grant Proposal Guide (NSF 04-23)
  - http://www.nsf.gov/publications/pub_summ.jsp?ods_key=GPG
- Science and Engineering Statistics
  - http:// www.nsf.gov/statistics/
- General Information
  - http://www.nsf.gov/