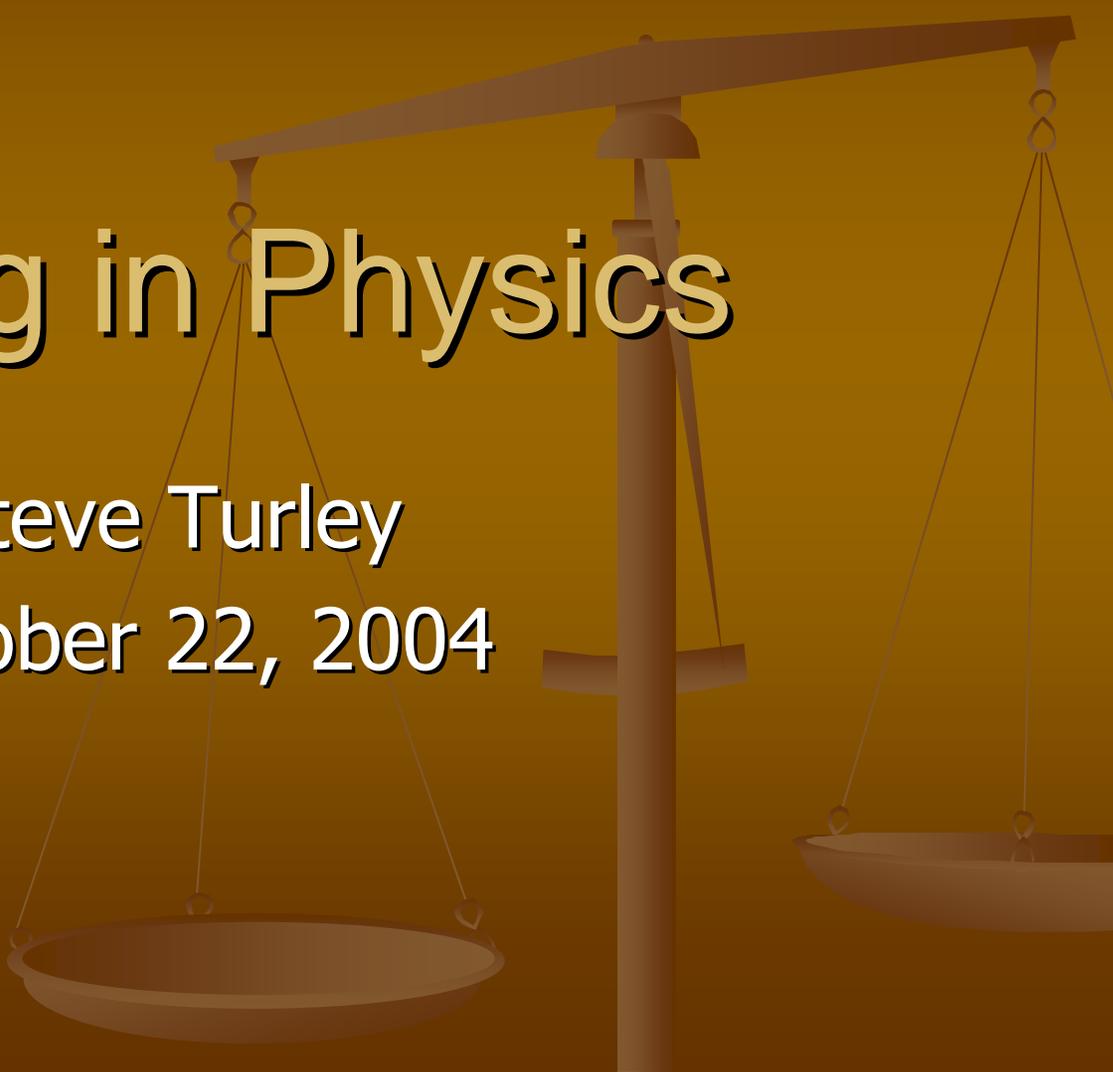


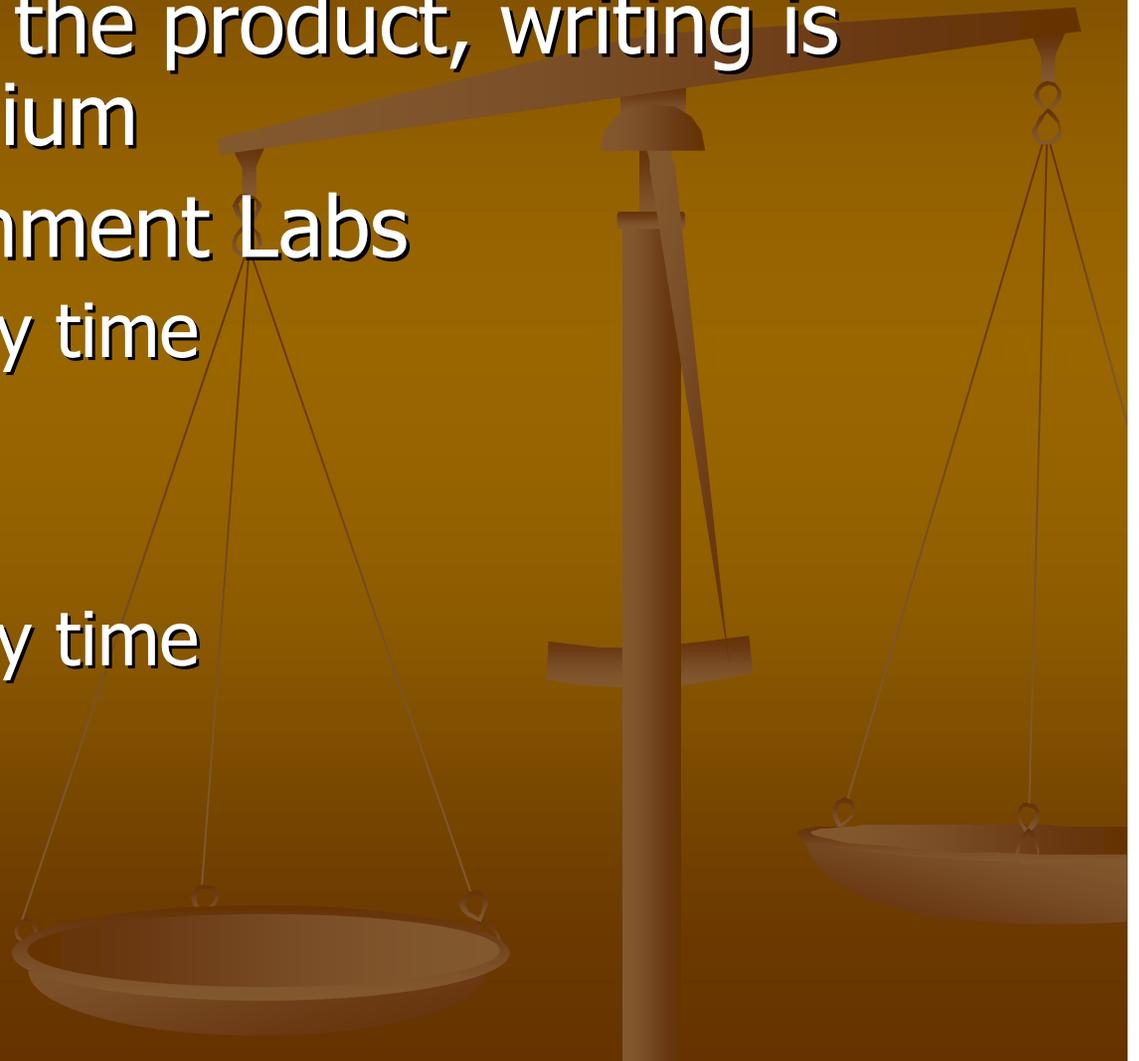
# Writing in Physics



Steve Turley  
October 22, 2004

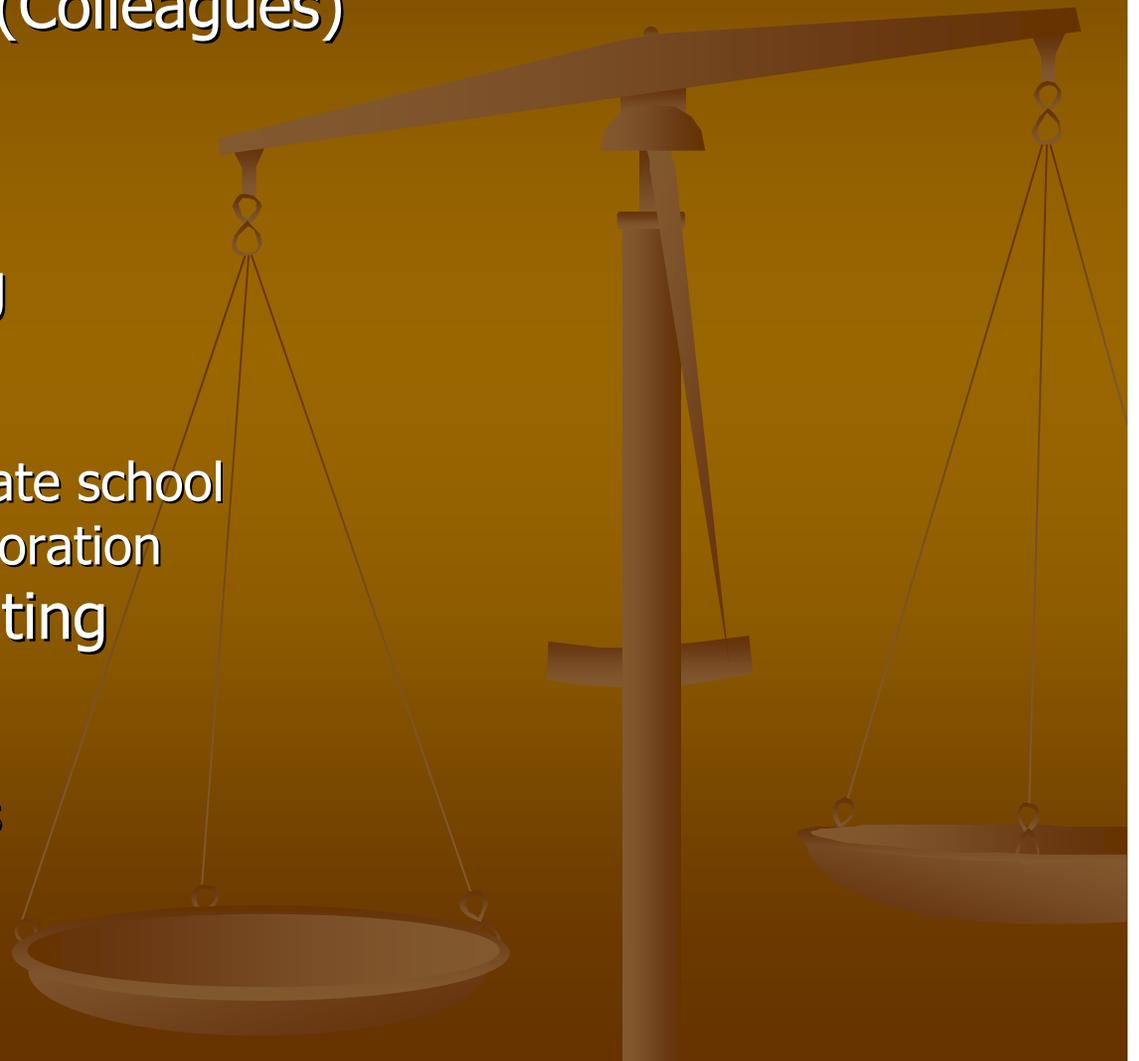
# What, Physicists Write?

- When ideas are the product, writing is usually the medium
- Industry/Government Labs
  - 20%-30% of my time
  - Examples
- University
  - 30%-40% of my time
  - Examples



# Kinds of Writing in Physics

- Technical Articles (Colleagues)
- Popular Writing
  - Textbooks
  - Public Information
- Persuasive Writing
  - Grant proposals
  - Job applications
  - Applying to graduate school
  - Proposing a collaboration
- Administrative Writing
  - Memos
  - Reports
  - Recommendations

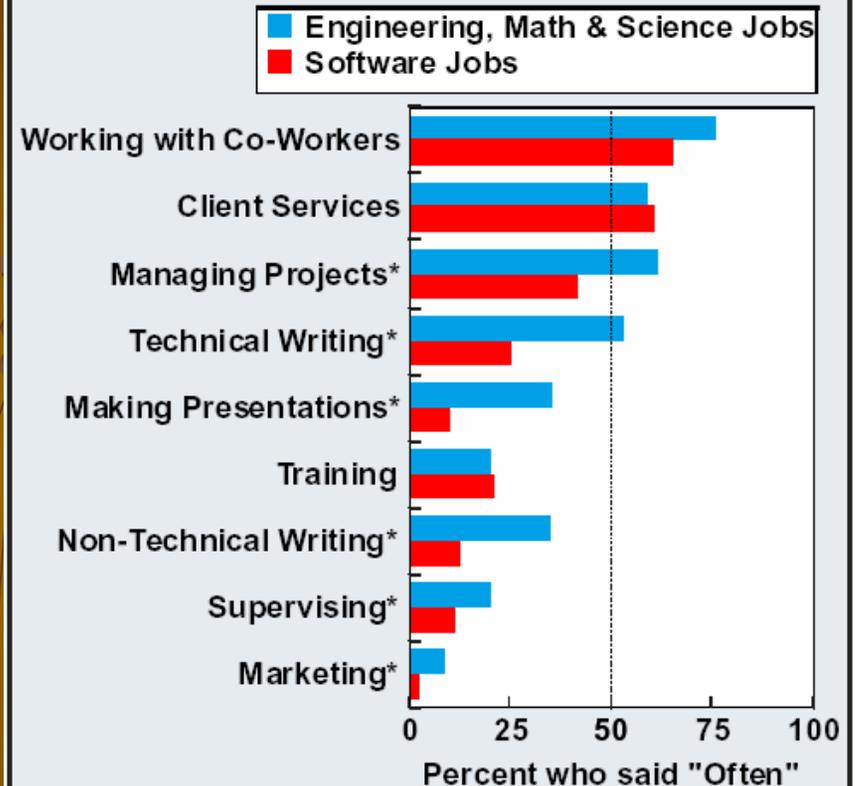


# Job Activities

- Supervisory Roles

- SME more likely in management
- Software just as likely to hire others (mostly CS)
- SME most like to hire engineers w/ physics as a close second (many more engineers in market than physicists)

Figure 3. Time Spent on Job Activities by Physics Bachelors 5 to 8 Years After Graduation



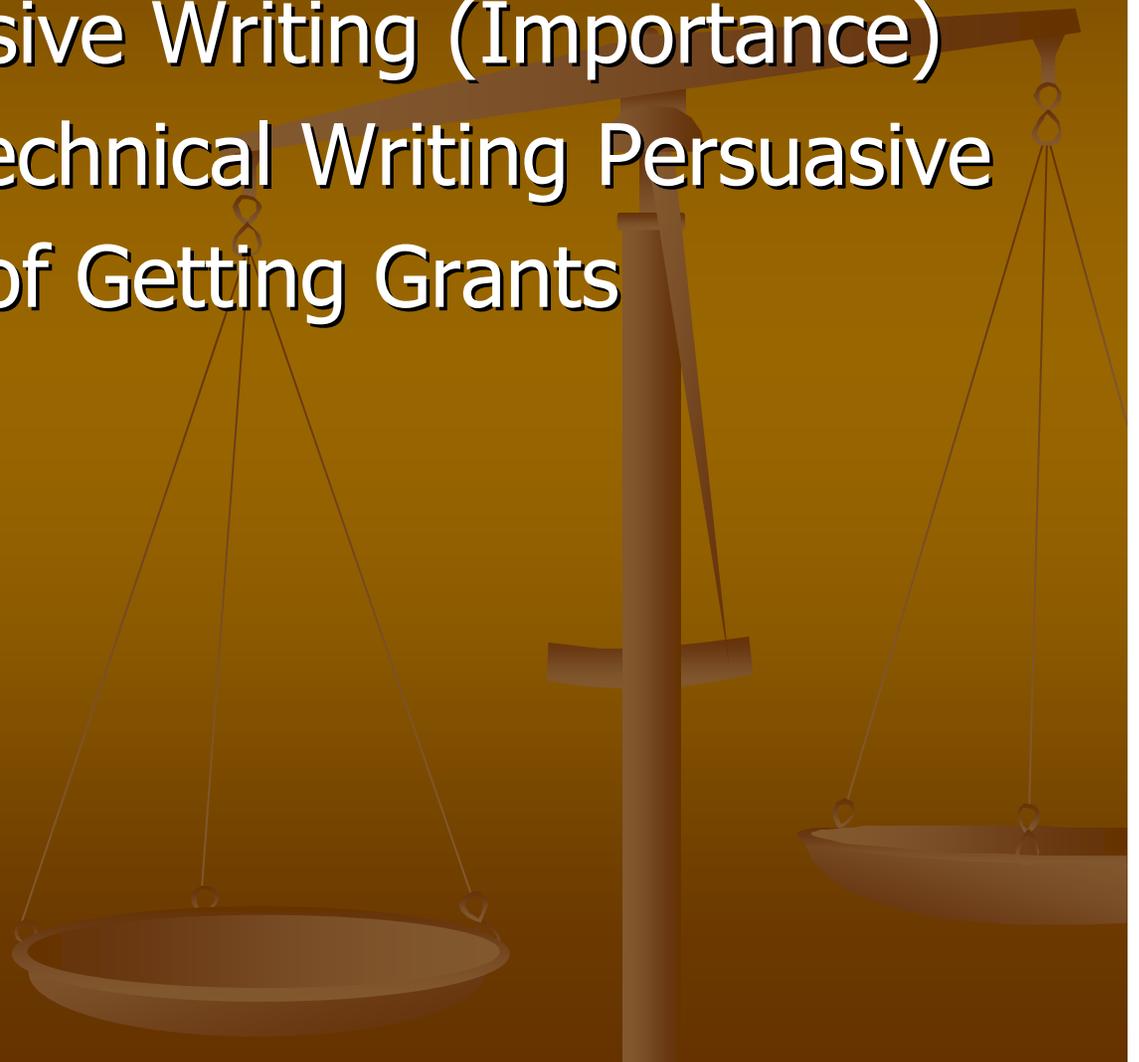
These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = none and 5 = extensive. Based on physics bachelors with no additional degrees who are not teachers or primarily students.

\*Differences between the two fields of employment are significant at  $\alpha \leq .05$ .

AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study

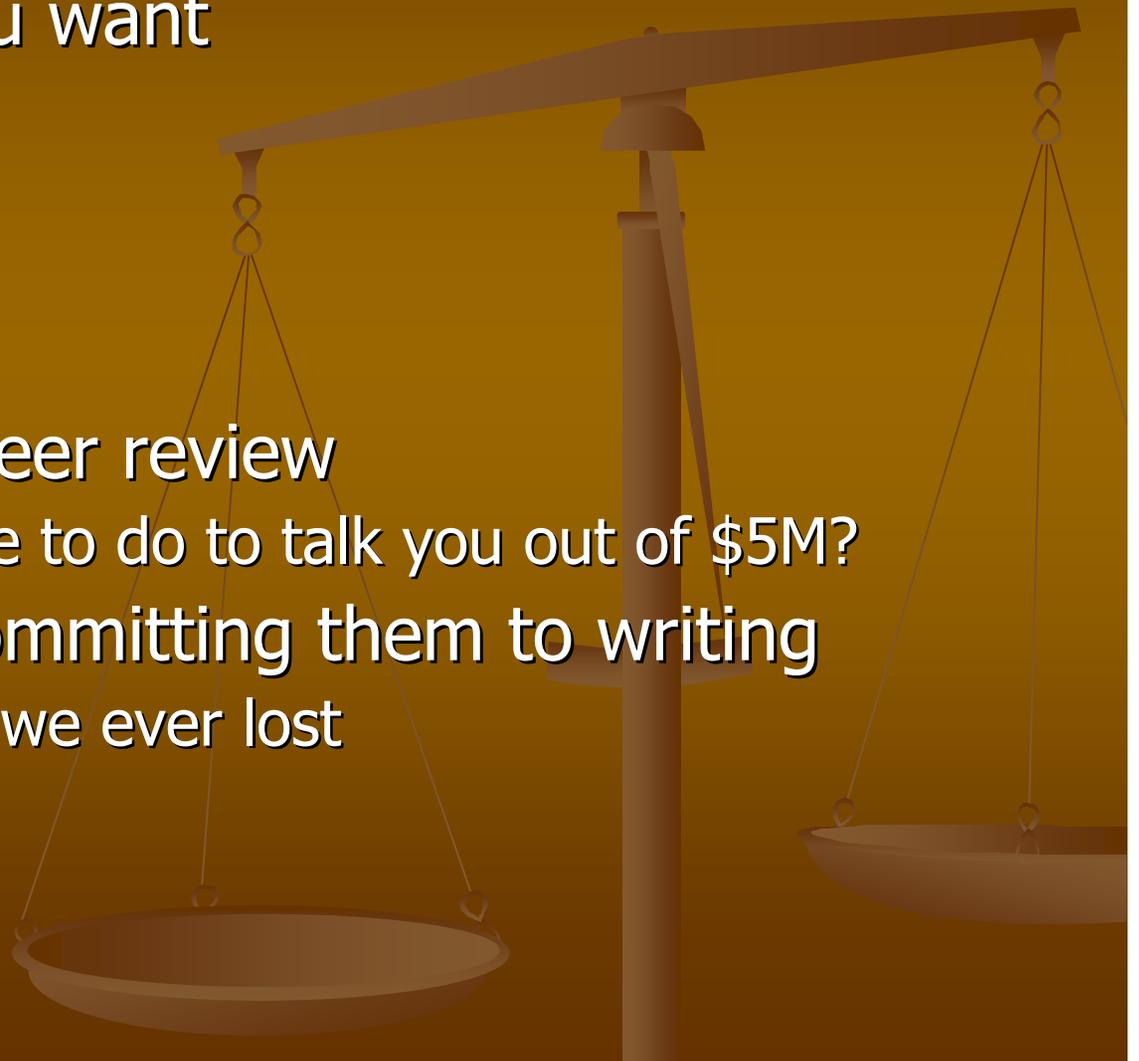
# Outline

- Why Do Persuasive Writing (Importance)
- How to Make Technical Writing Persuasive
- Nuts and Bolts of Getting Grants
- Highlights

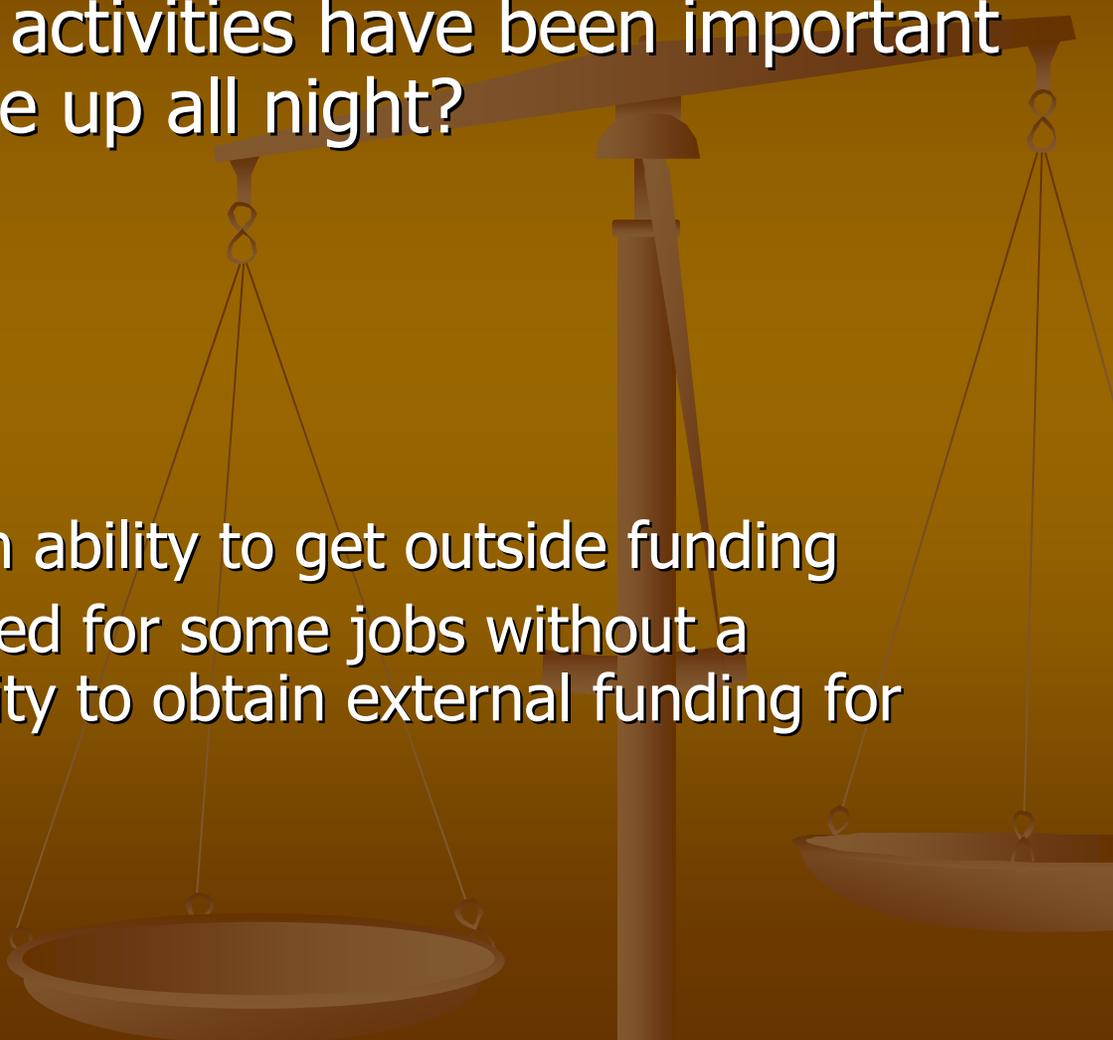


# Why Do Persuasive Writing?

- Get something you want
  - Money
  - Position
  - Opportunity
  - Equipment
- Subject ideas to peer review
  - What would I have to do to talk you out of \$5M?
- Refine ideas by committing them to writing
  - The best contract we ever lost



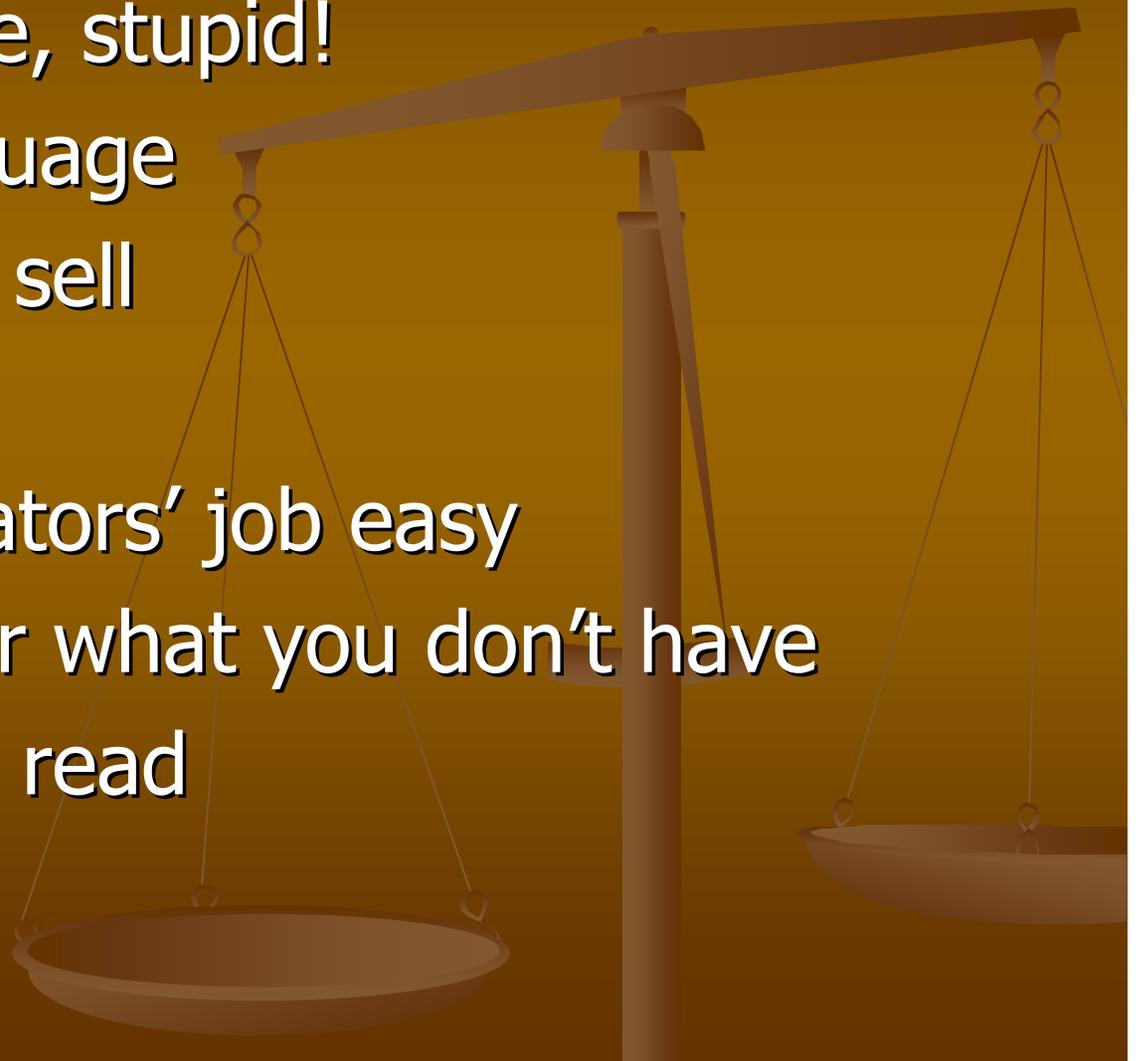
# Professional Importance



- What professional activities have been important enough to keep me up all night?
  - Hughes
  - BYU
  - M.I.T.
- Bottom line
  - Career depends on ability to get outside funding
  - You will not be hired for some jobs without a demonstrated ability to obtain external funding for your research

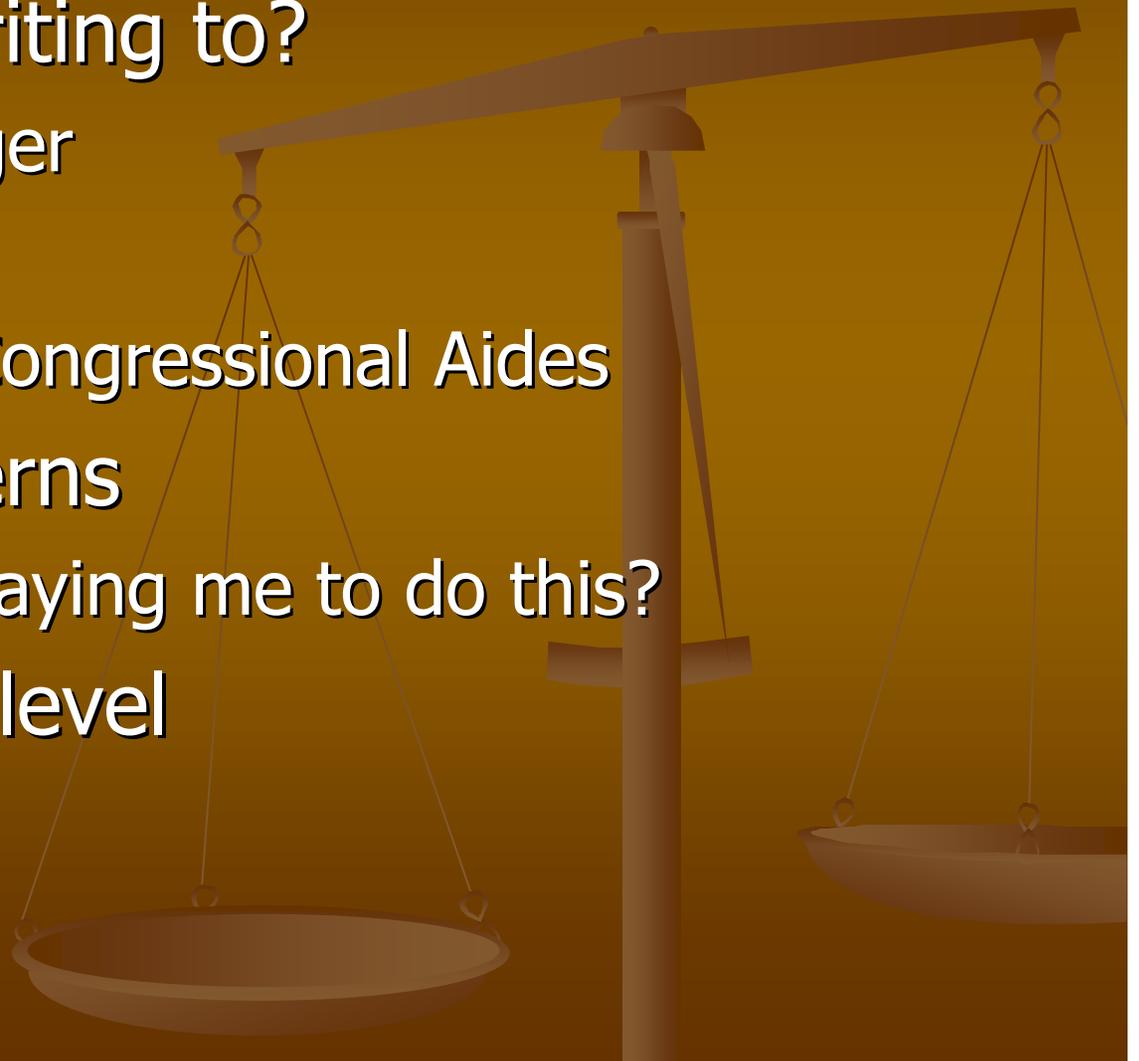
# Making Technical Writing Persuasive

- It's the audience, stupid!
- Use strong language
- Persuade, don't sell
- Get feedback
- Make the evaluators' job easy
- You can't deliver what you don't have
- Making it fun to read

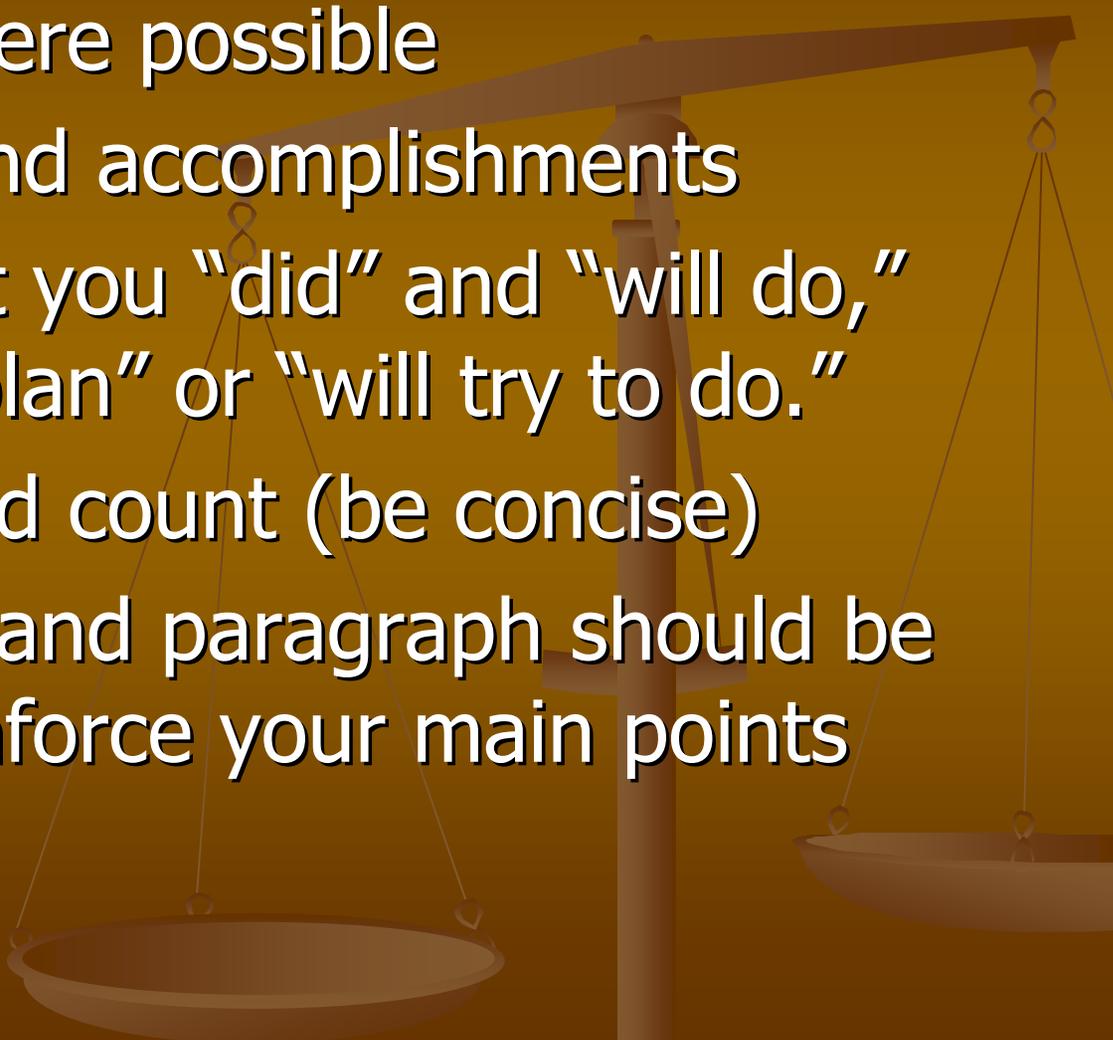


# It's the Audience Stupid

- Who are you writing to?
  - Program Manager
  - Administrator
  - Congress and Congressional Aides
- Customer concerns
  - Why are they paying me to do this?
- Writing at their level



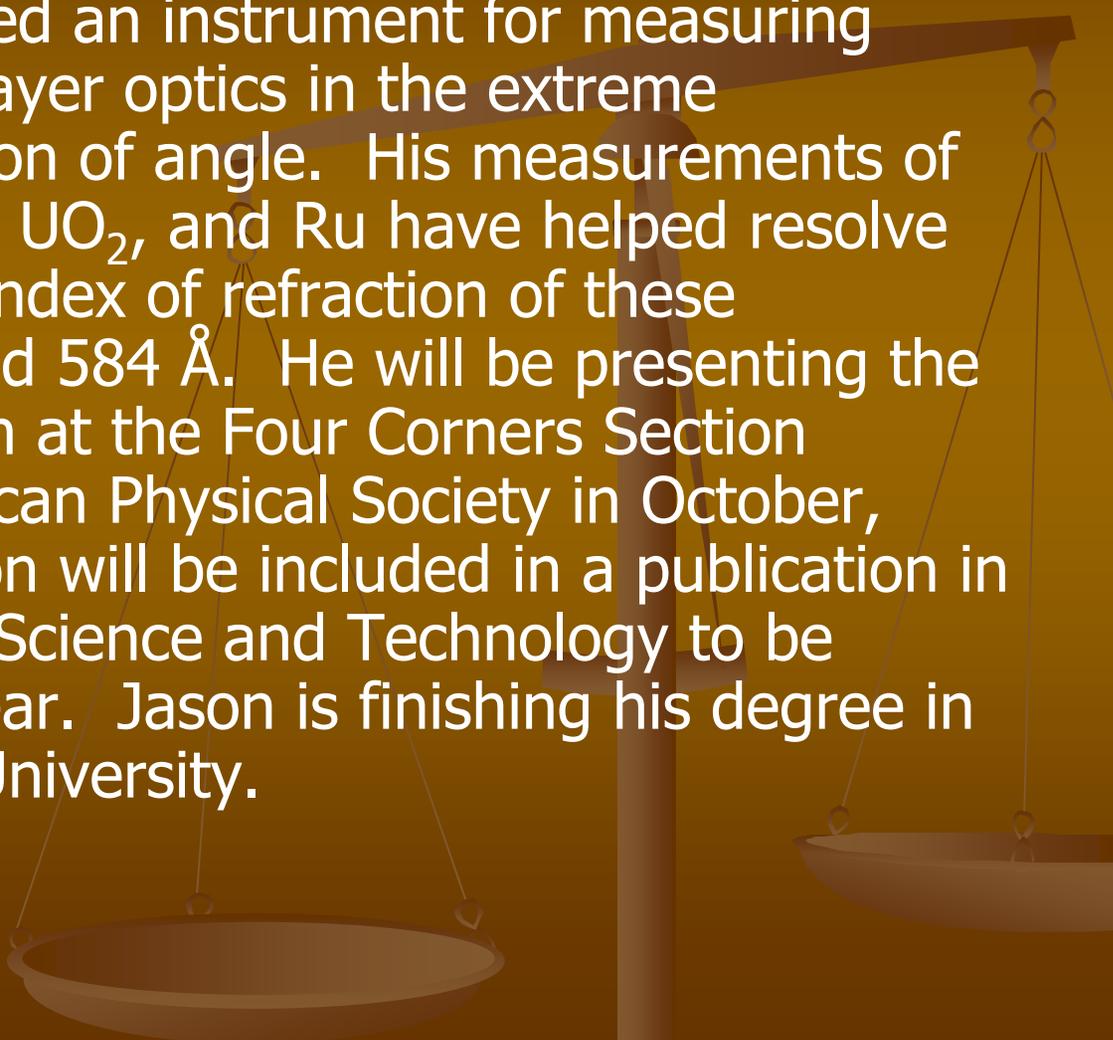
# Use Strong Language



- Active verbs where possible
- Specific goals and accomplishments
- Talk about what you “did” and “will do,” not what you “plan” or “will try to do.”
- Make every word count (be concise)
- Every sentence and paragraph should be designed to reinforce your main points

# *Good Example*

Jason Rowland developed an instrument for measuring reflectivities of multilayer optics in the extreme ultraviolet as a function of angle. His measurements of the reflectivities of U, UO<sub>2</sub>, and Ru have helped resolve questions about the index of refraction of these materials at 304 Å and 584 Å. He will be presenting the results of his research at the Four Corners Section Meeting of the American Physical Society in October, 1999. His contribution will be included in a publication in the Journal of X-Ray Science and Technology to be prepared later this year. Jason is finishing his degree in physics at Pt. Loma University.

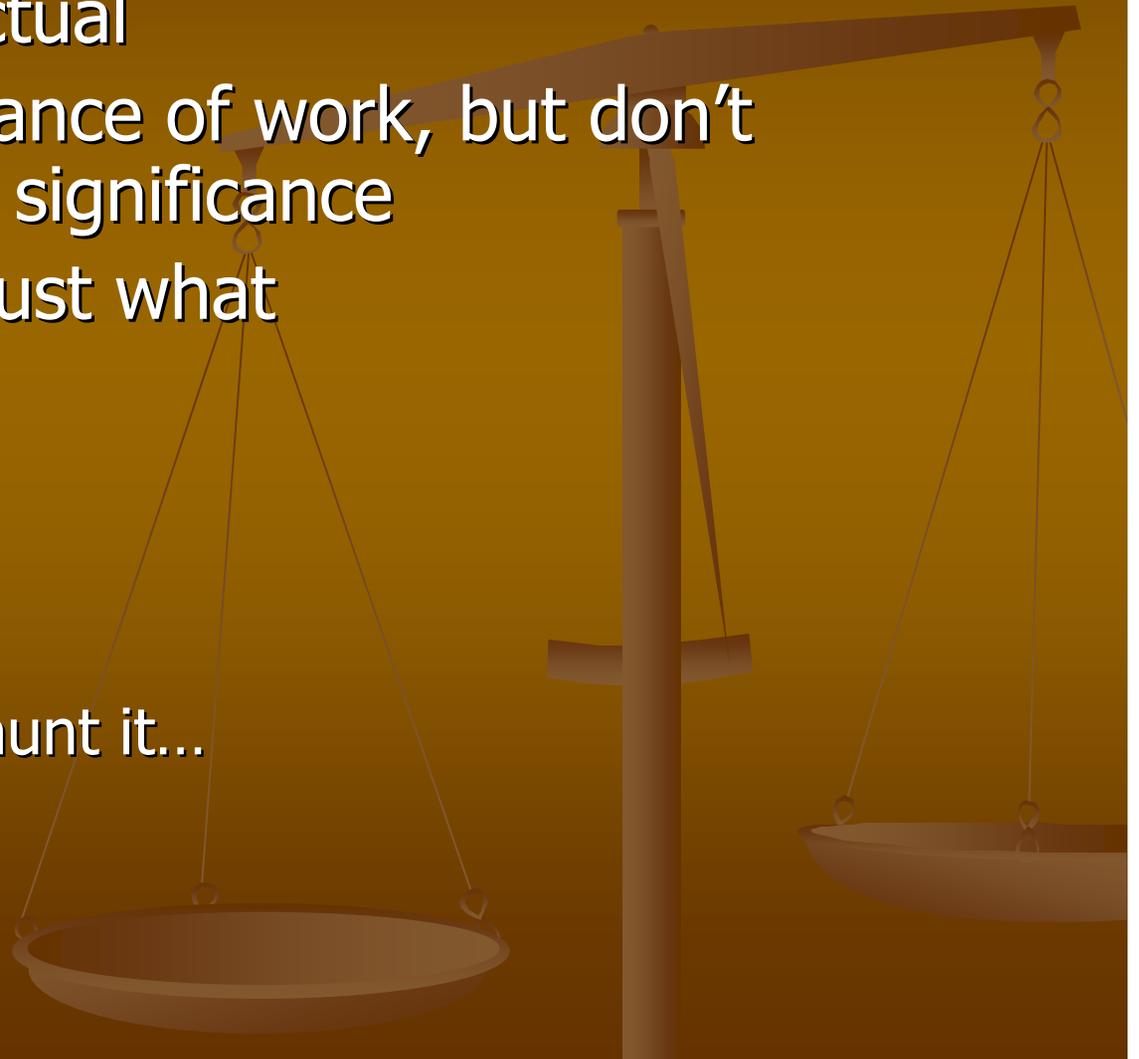


# *Bad Example*

An absolute measurement of the  $^{16}\text{O}(\gamma, p)^{15}\text{N}$  differential cross section for an incident photon energy of 200 MeV was made at the M.I.T. Bates Linear Accelerator. Measurements were made at proton angles of  $20^\circ$ ,  $30^\circ$ ,  $40^\circ$ ,  $50^\circ$ ,  $70^\circ$ ,  $90^\circ$ , and  $110^\circ$ . Cross sections for the process leaving the residual  $^{15}\text{N}$  nucleus in its ground state as well as information about the reactions leading to excited states have been extracted. The ground state differential cross section has been integrated to obtain a total cross section at this energy.

# Persuade, don't sell

- Be precise and factual
- Emphasize importance of work, but don't overemphasize its significance
- Explain why, not just what
  - Importance
  - Significance
  - Capabilities
- Don't be shy
  - If you've got it, flaunt it...



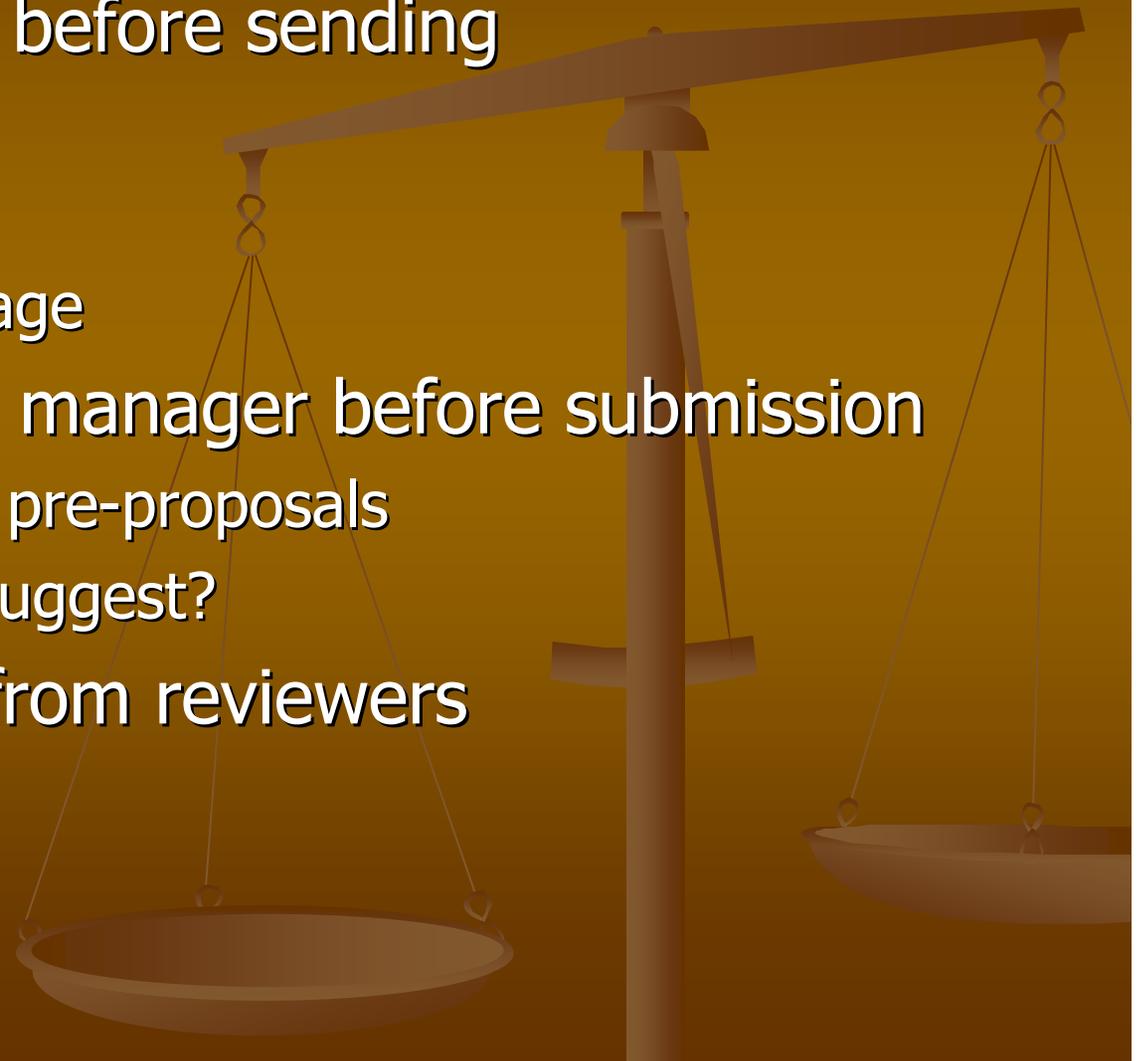
# Good Example

Brigham Young University is particularly successful in motivating students to pursue careers in physics and in the physical sciences. The American Institute of Physics reported that in 1997-98 BYU had a 50% higher enrollment in introductory physics courses (9540) than any other U.S. university. In an era of generally declining undergraduate enrollments, our department has seen an increase from 149 to 220 undergraduate majors in the past ten years. In 1998, our department was ranked eighth nationally in the number of physics baccalaureate degrees granted.

1. American Institute of Physics publication R-394.5, August, 1999.
2. American Institute of Physics publication R-151.35, March, 1999.
3. Ramon Lopez, "Science Education Revolution in the United States: An APS View." Special Issue of APS News, January 1998.
4. P. F. Schewe and B. Stein, Physics News Update, The AIP Bulletin of Physics News, #383, July 24, 1998.

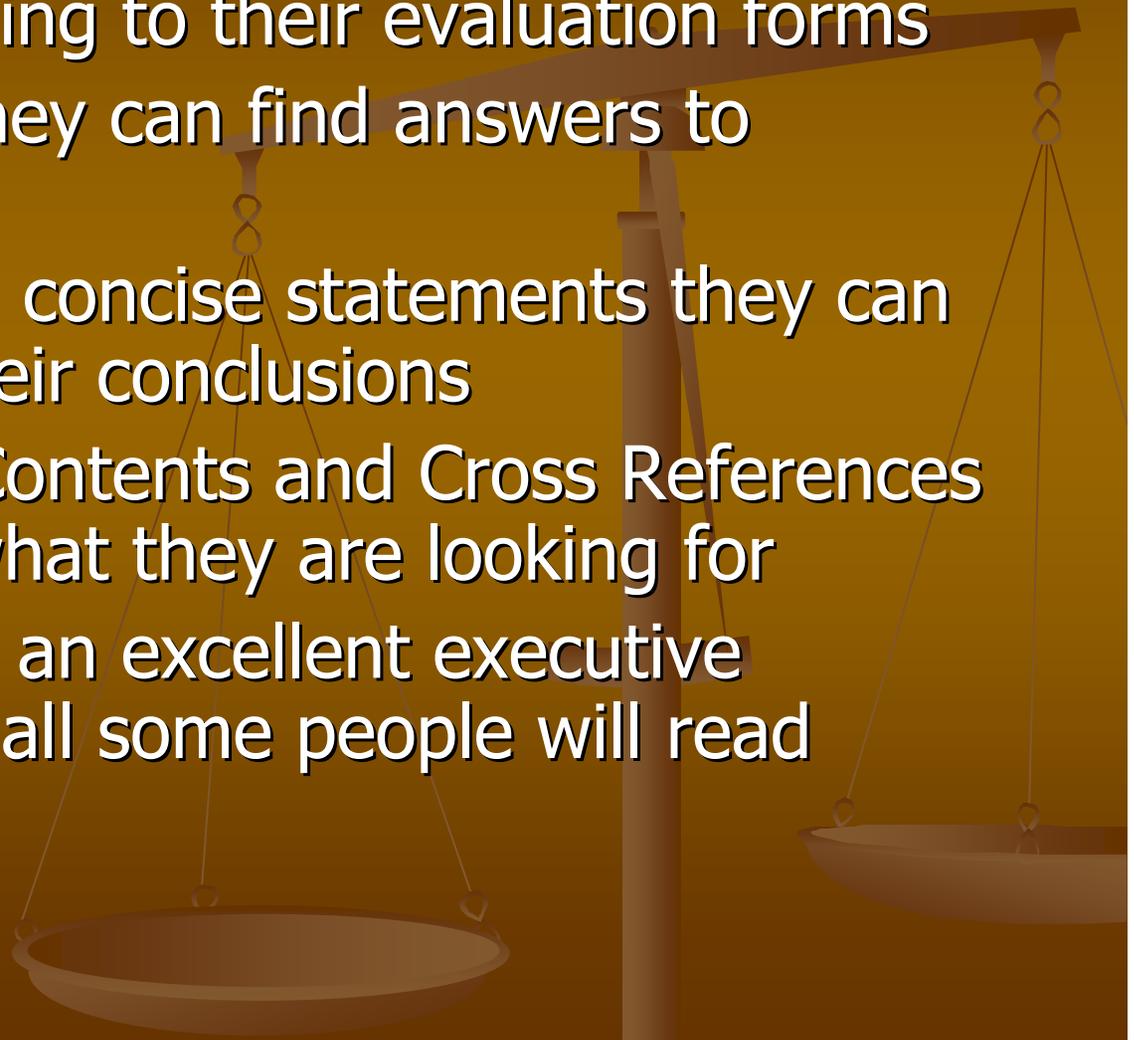
# Get Feedback

- Review by friends before sending
  - Content
  - Typos
  - Strength of language
- Speak to program manager before submission
  - White papers and pre-proposals
  - What would you suggest?
- Ask for feedback from reviewers



# Making the Evaluators' Job Easy

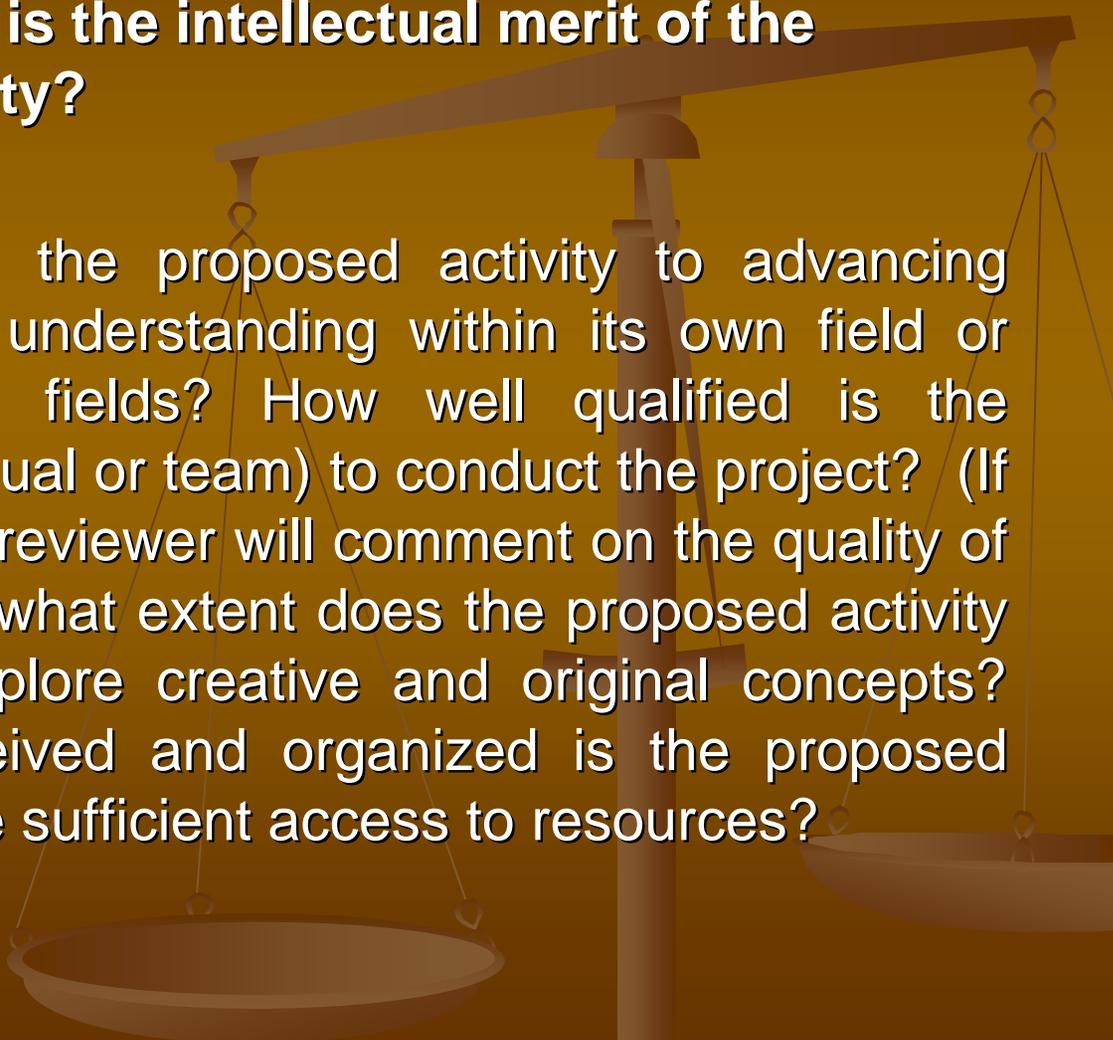
- Organize it according to their evaluation forms
- Highlight where they can find answers to evaluation criteria
- Provide them with concise statements they can quote to justify their conclusions
- Provide Table of Contents and Cross References so it is is to find what they are looking for
- Be sure to include an excellent executive summary—that is all some people will read



# NSF Review Criterion 1

## **Criterion 1: What is the intellectual merit of the proposed activity?**

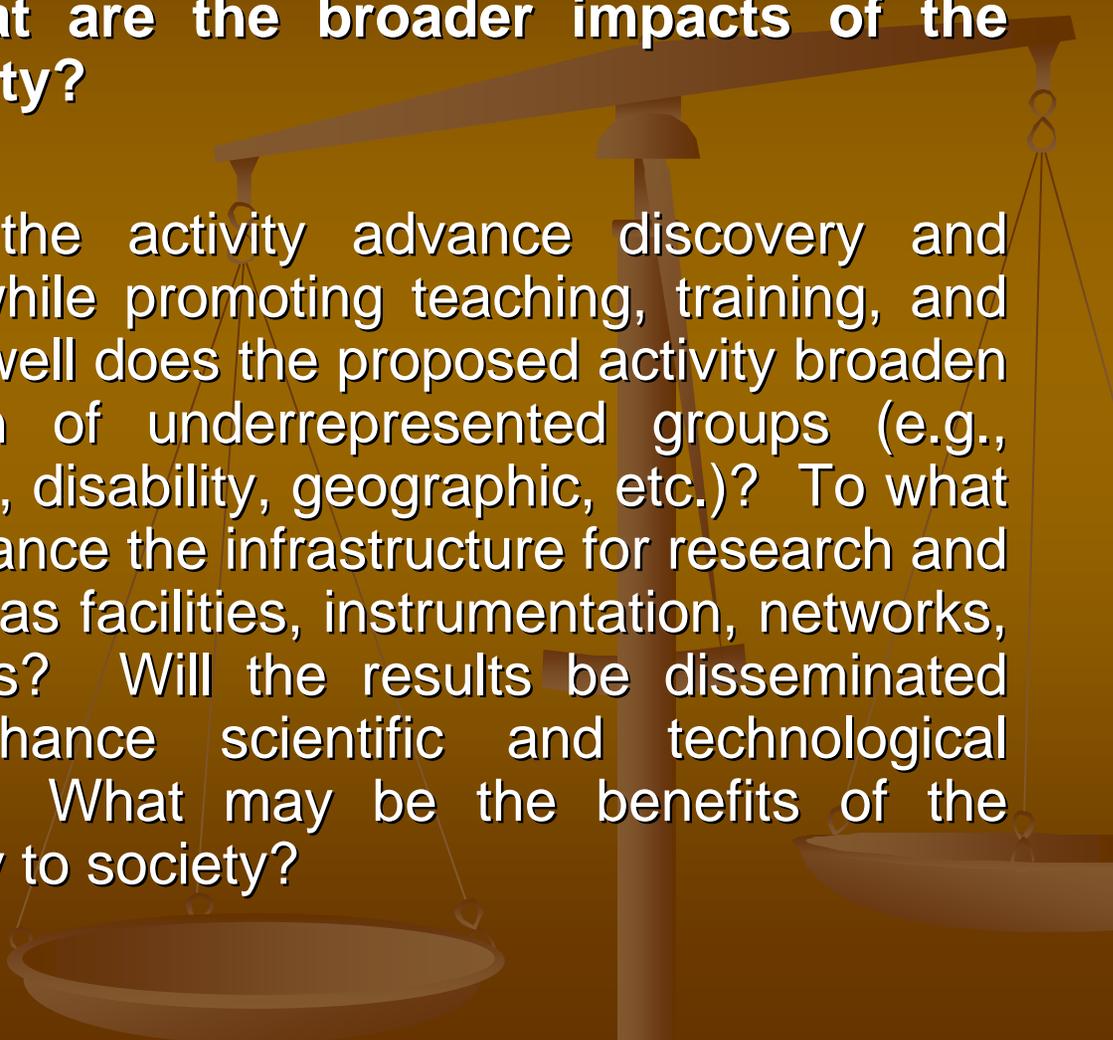
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?



# NSF Review Criterion 2

**Criterion 2: What are the broader impacts of the proposed activity?**

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent 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 society?



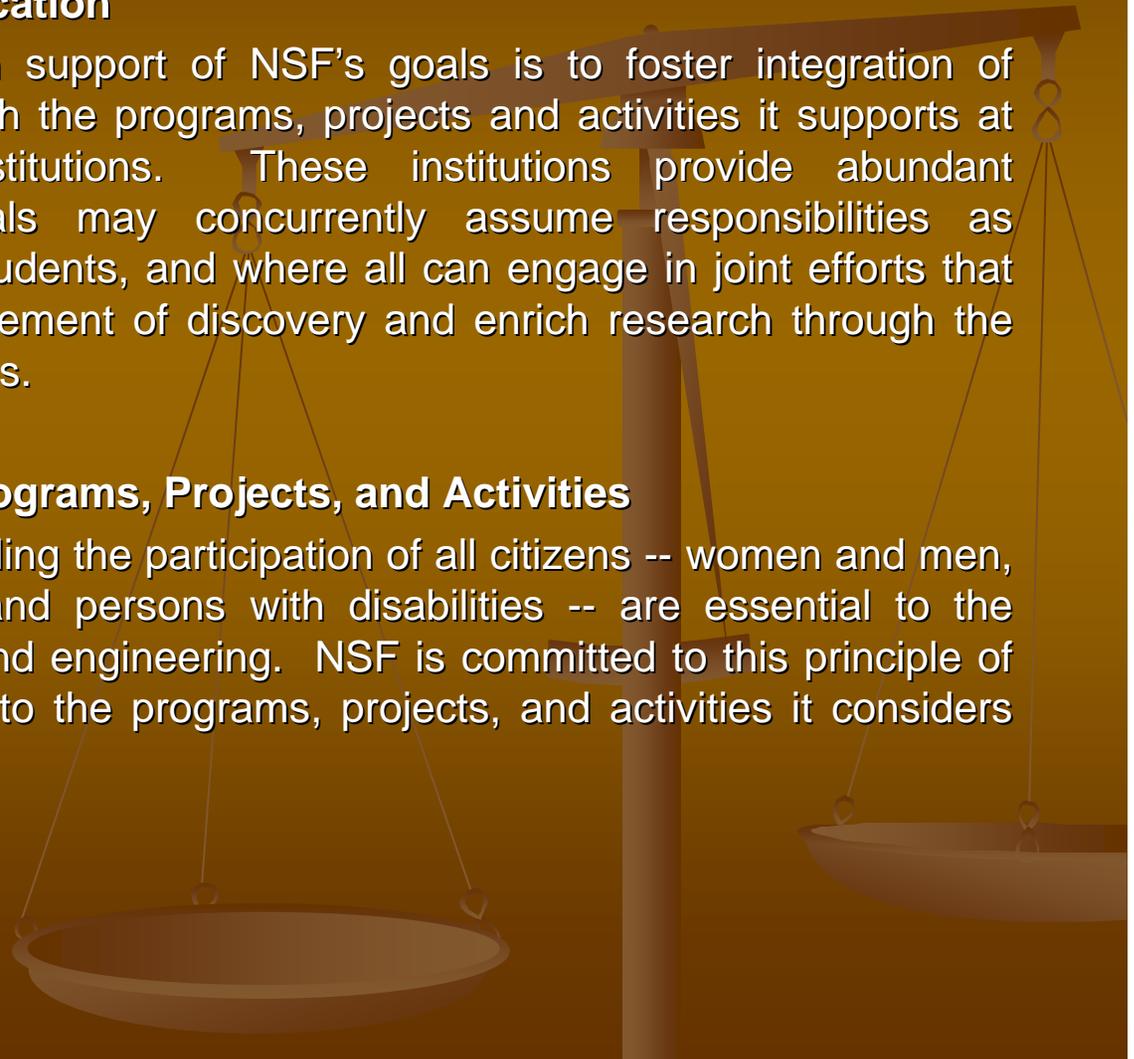
# Other NSF Issues

## **Integration of Research and Education**

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

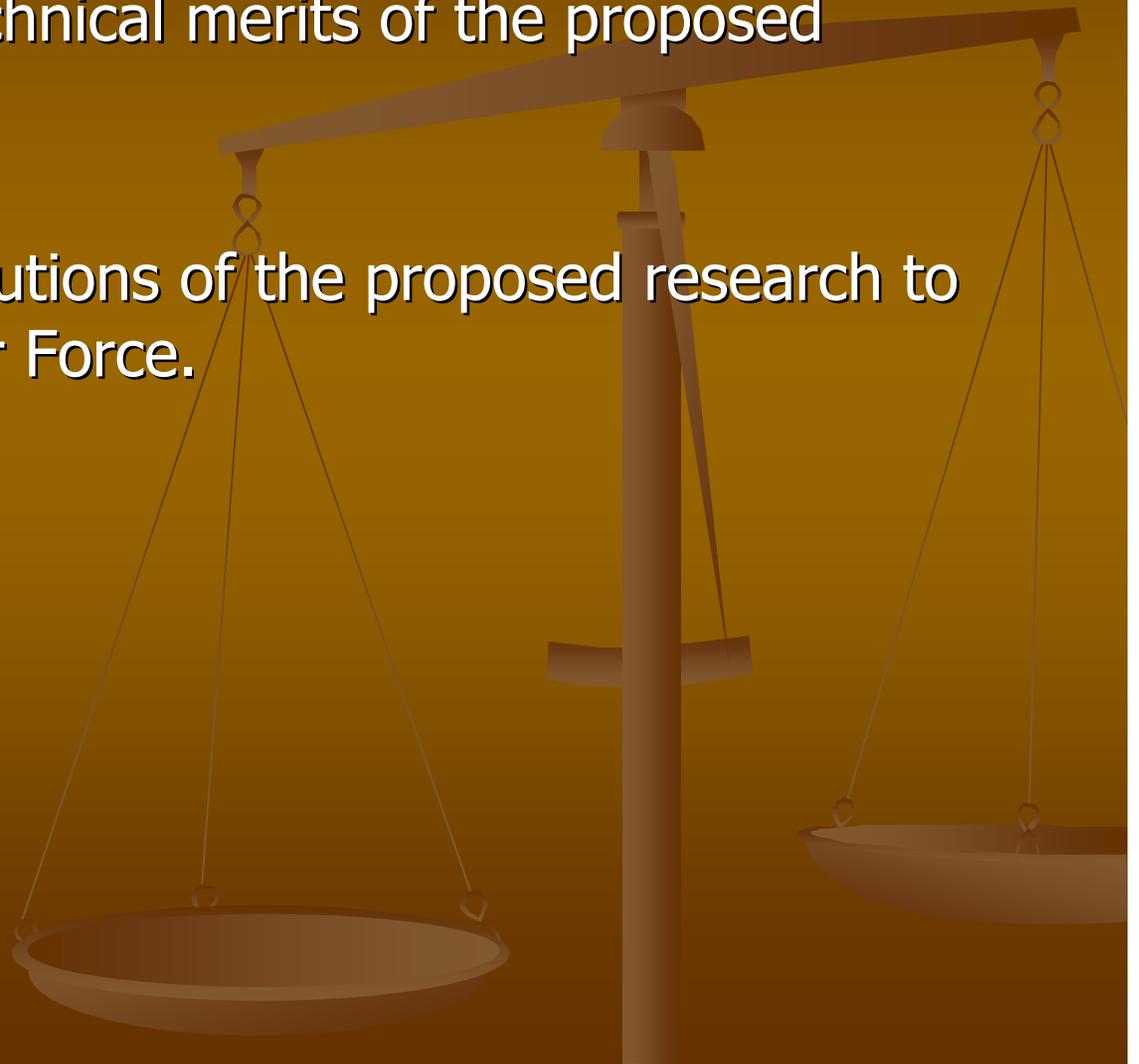
## **Integrating Diversity into NSF Programs, Projects, and Activities**

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- are essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.



# Primary AFOSR Review Criteria

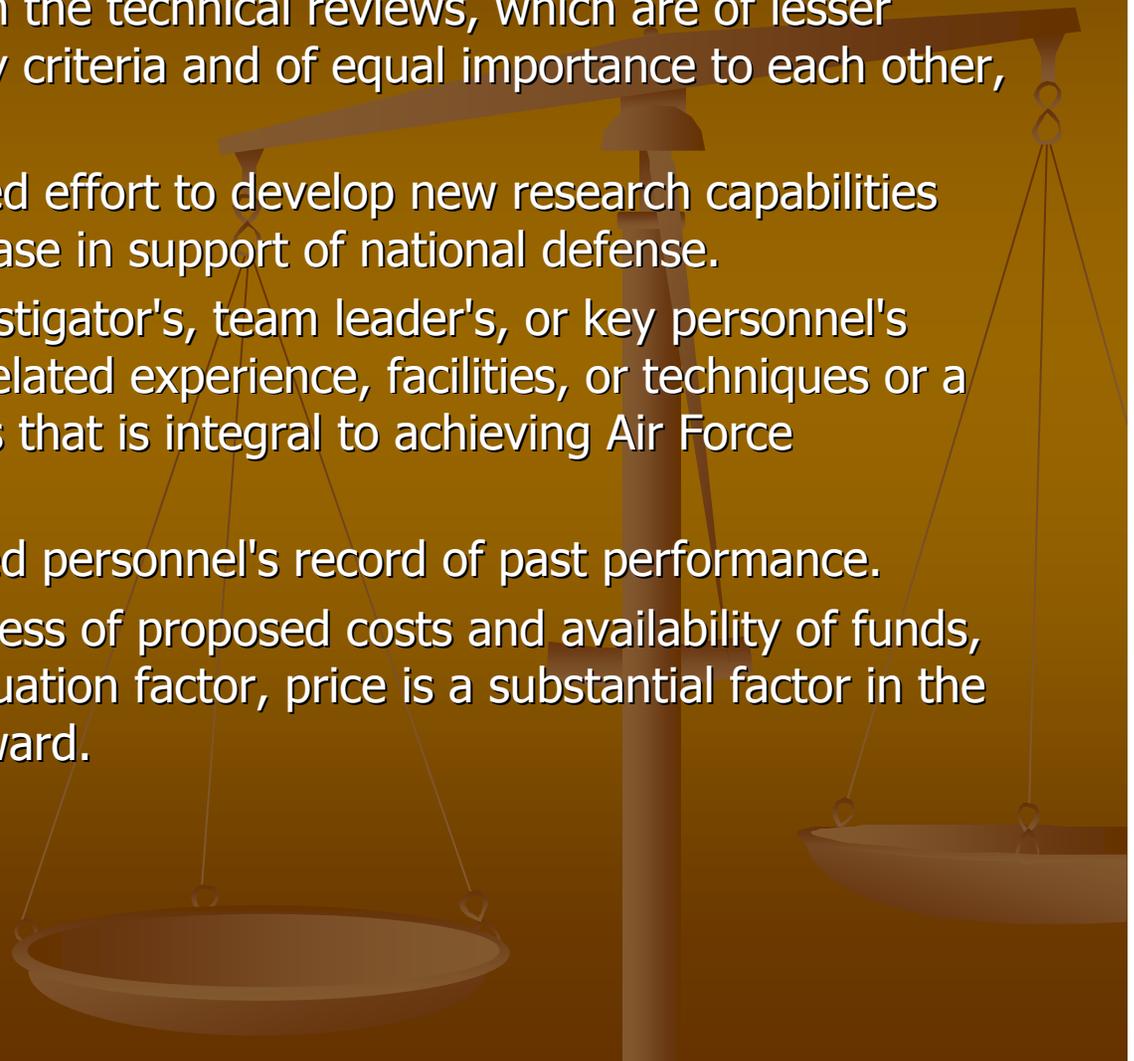
1. The scientific and technical merits of the proposed research.
2. The potential contributions of the proposed research to the mission of the Air Force.



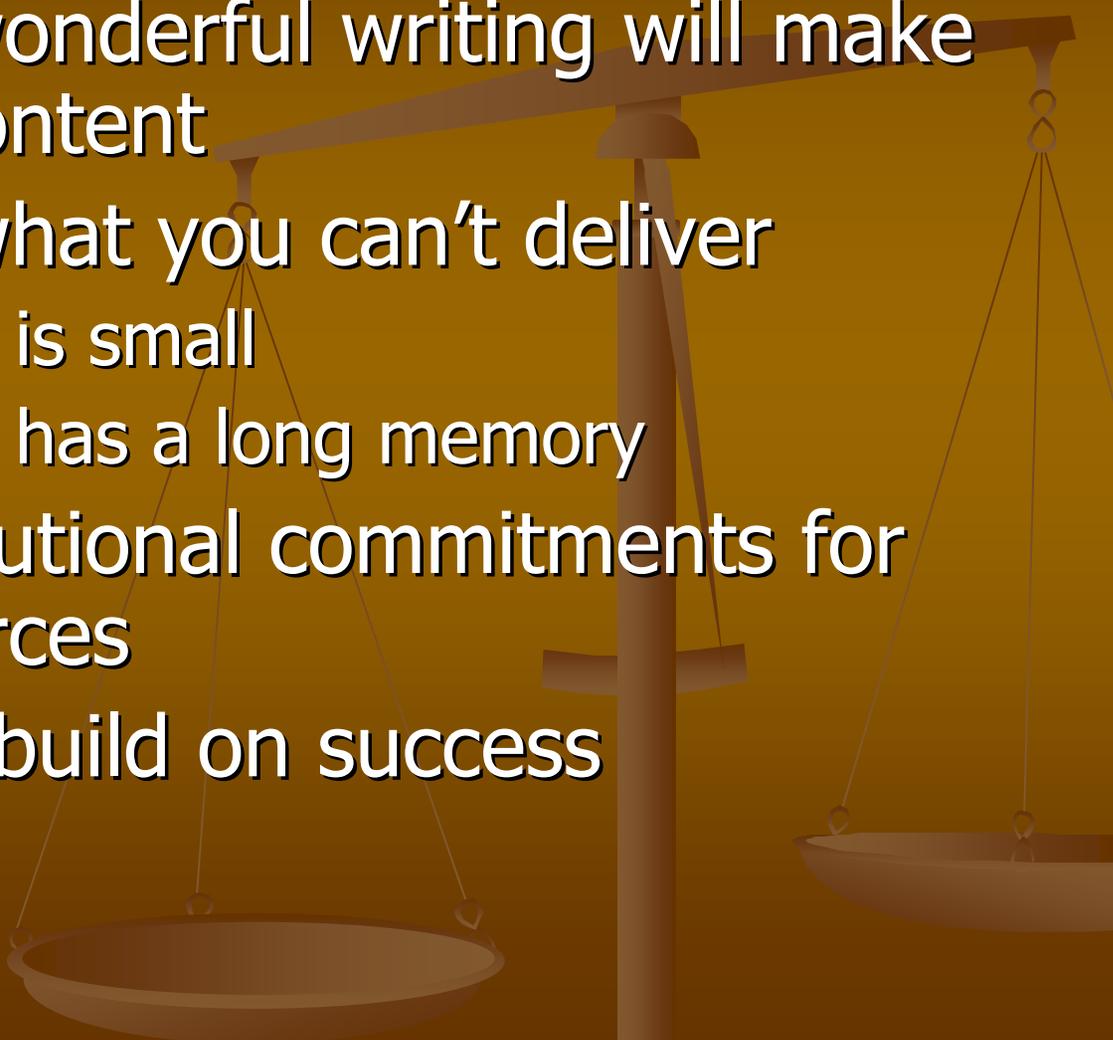
## Secondary AFOSR Criteria

Other evaluation criteria used in the technical reviews, which are of lesser importance than the primary criteria and of equal importance to each other, are as follows:

1. The likelihood of the proposed effort to develop new research capabilities and broaden the research base in support of national defense.
2. The proposer's principal investigator's, team leader's, or key personnel's qualifications, capabilities, related experience, facilities, or techniques or a combination of these factors that is integral to achieving Air Force objectives.
3. The proposer's and associated personnel's record of past performance.
4. The realism and reasonableness of proposed costs and availability of funds, although not a primary evaluation factor, price is a substantial factor in the selection of proposals for award.

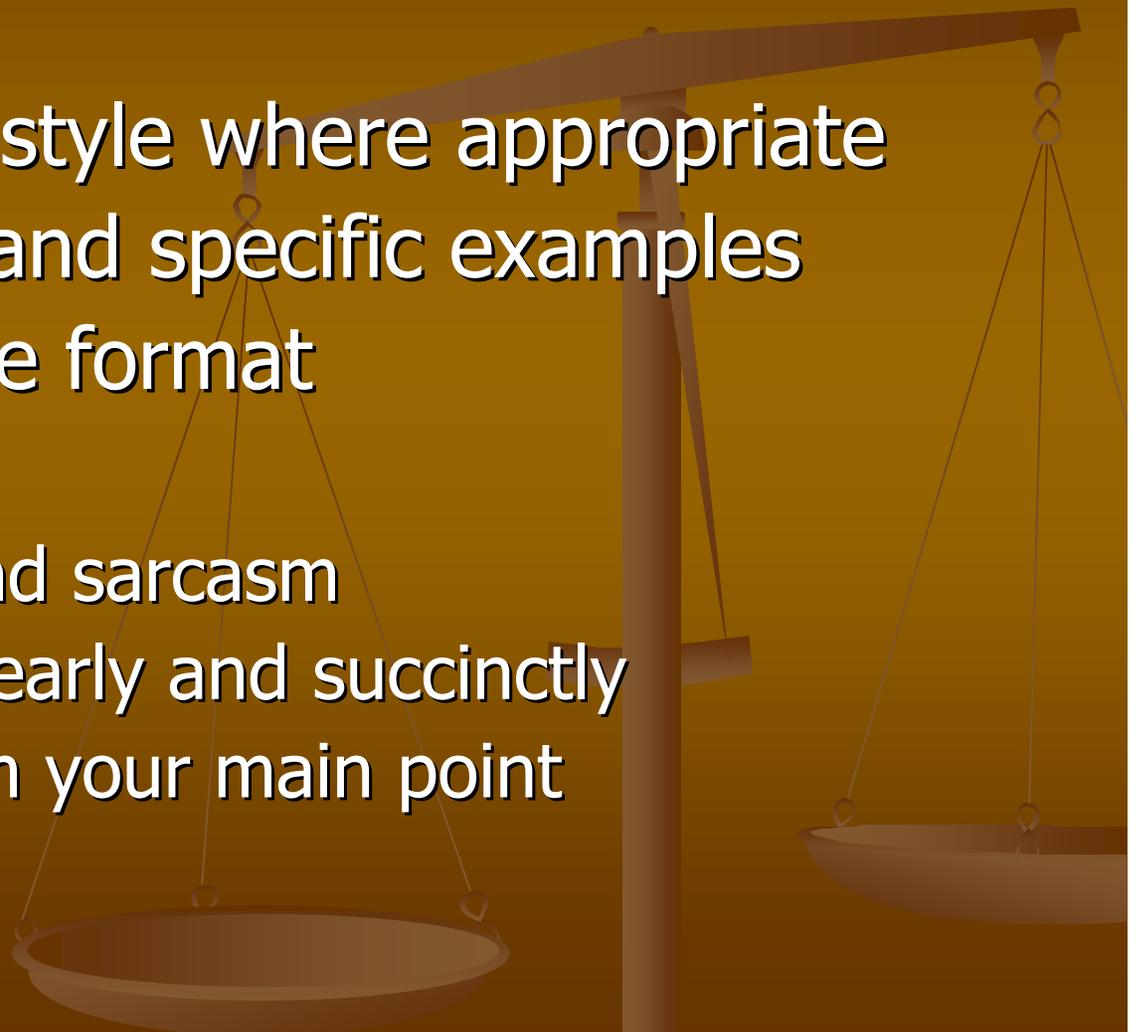


# You Can't Deliver What You Don't Have

- No amount of wonderful writing will make up for lack of content
  - Don't promise what you can't deliver
    - The community is small
    - The community has a long memory
  - Be sure of institutional commitments for matching resources
  - Start small and build on success
- 

# Making it Fun to Read

- Tell a story
- Use a narrative style where appropriate
- Add anecdotes and specific examples
- Use an attractive format
- But...
  - Avoid humor and sarcasm
  - Present facts clearly and succinctly
  - Don't stray from your main point



# Example with Richard Feynman

- “Now we may wonder why we bother to give this other solution, since we were so happy with the first one all by itself. What is the extra one for, because of course we know we should only take the real part? *We* know that we must take the real part, but how did the *mathematics* know that we only wanted the real part?”

# Example with Grometstein

- “The belief that matter is homogeneous died out slowly. When Niels Bohr delivered his Nobel Prize speech in 1922, he did not feel it inappropriate to remind his audience that scientists ‘believe the existence of atoms to be proved beyond a doubt.’ This was one of those ‘needless to say’ remarks which the speaker feels obliged to say.”

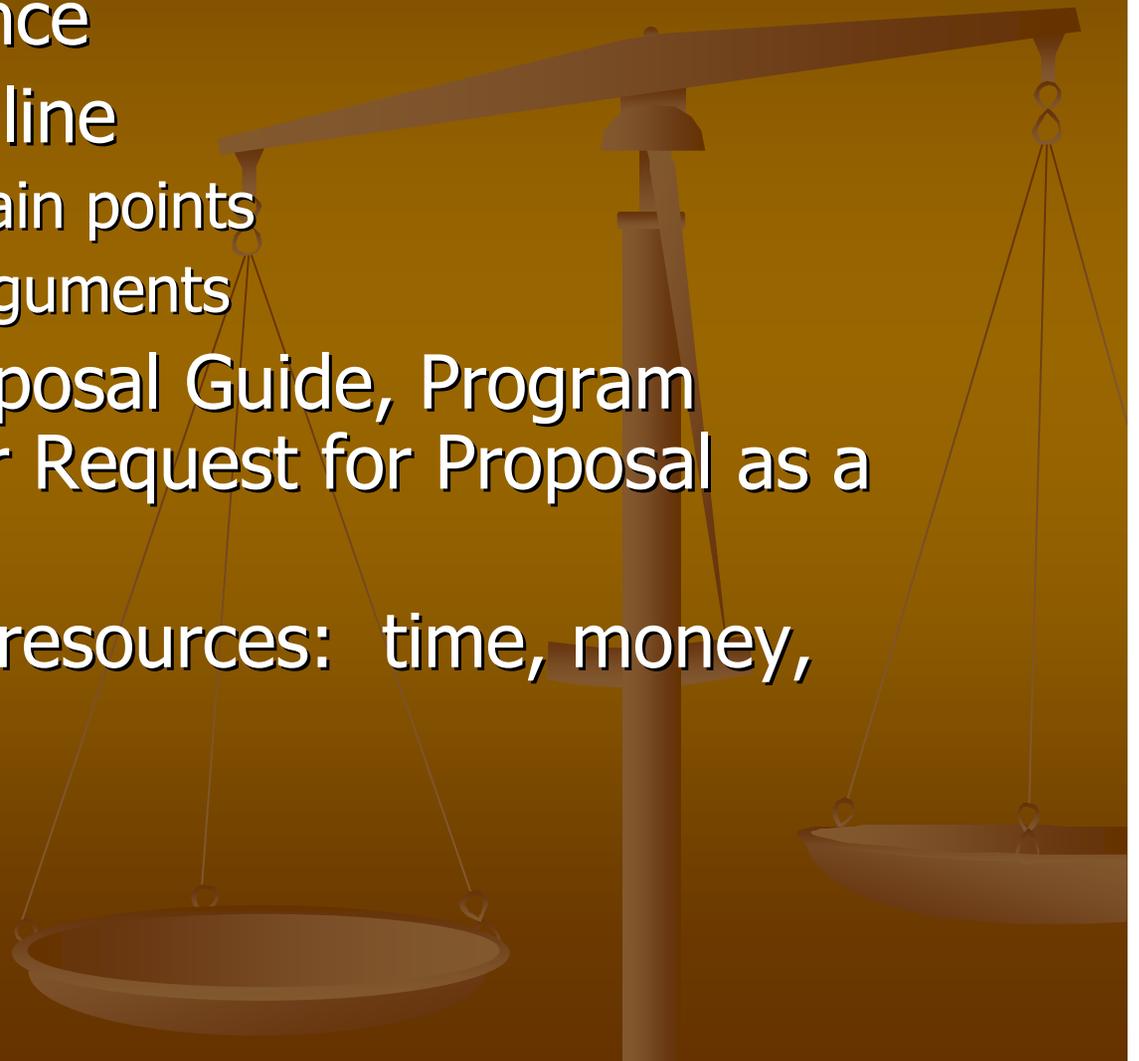
# Nuts and Bolts of Getting Grants

- Planning Process
- Group/Individual Effort
- Identifying Sponsors
- Size of Awards
- General Content



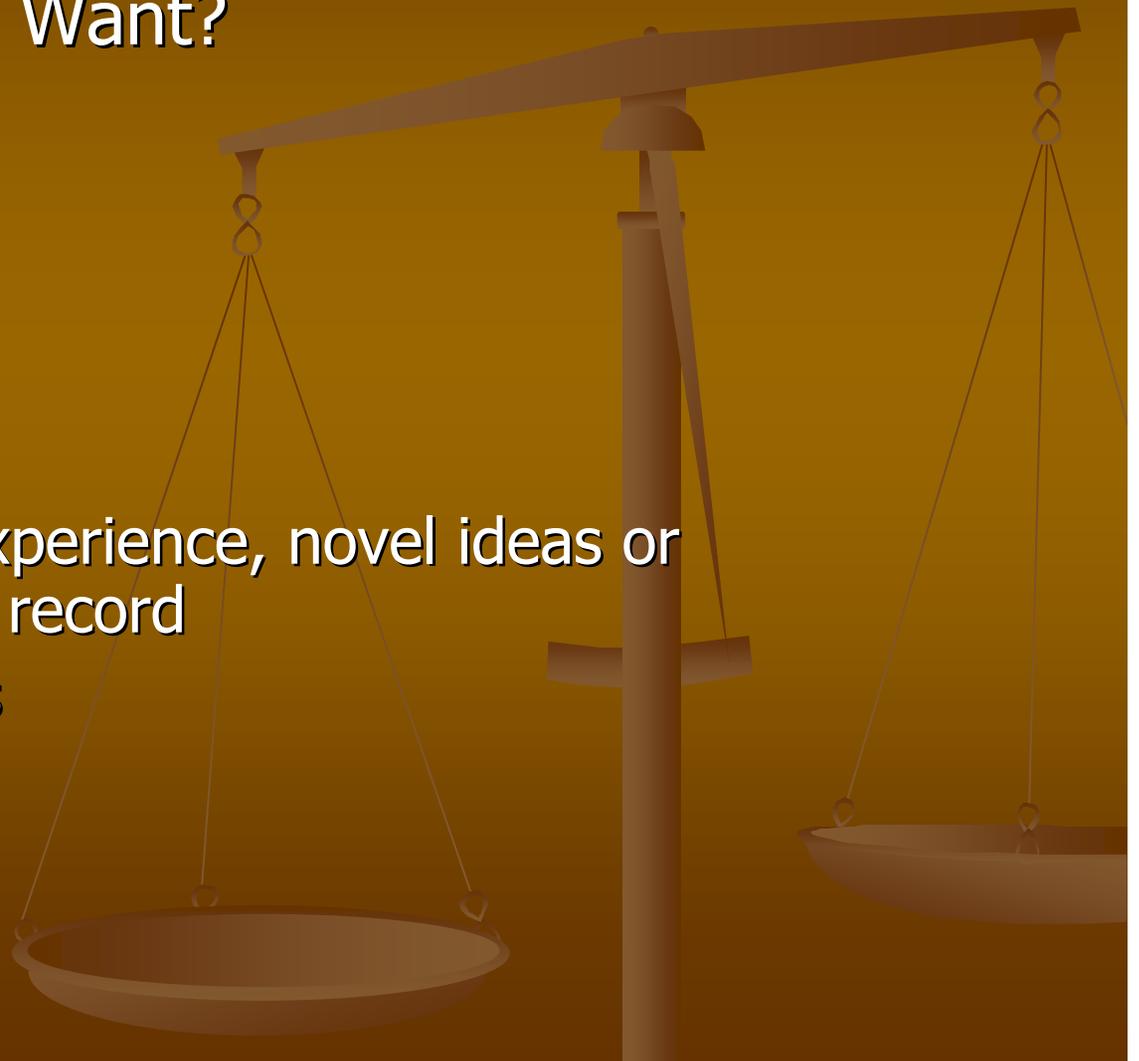
# Planning Process

- Start well in advance
- Decide on a story line
  - Visually outline main points
  - Plug in support arguments
- Use the Grant Proposal Guide, Program Announcement, or Request for Proposal as a Bible
- Allocate plenty of resources: time, money, people



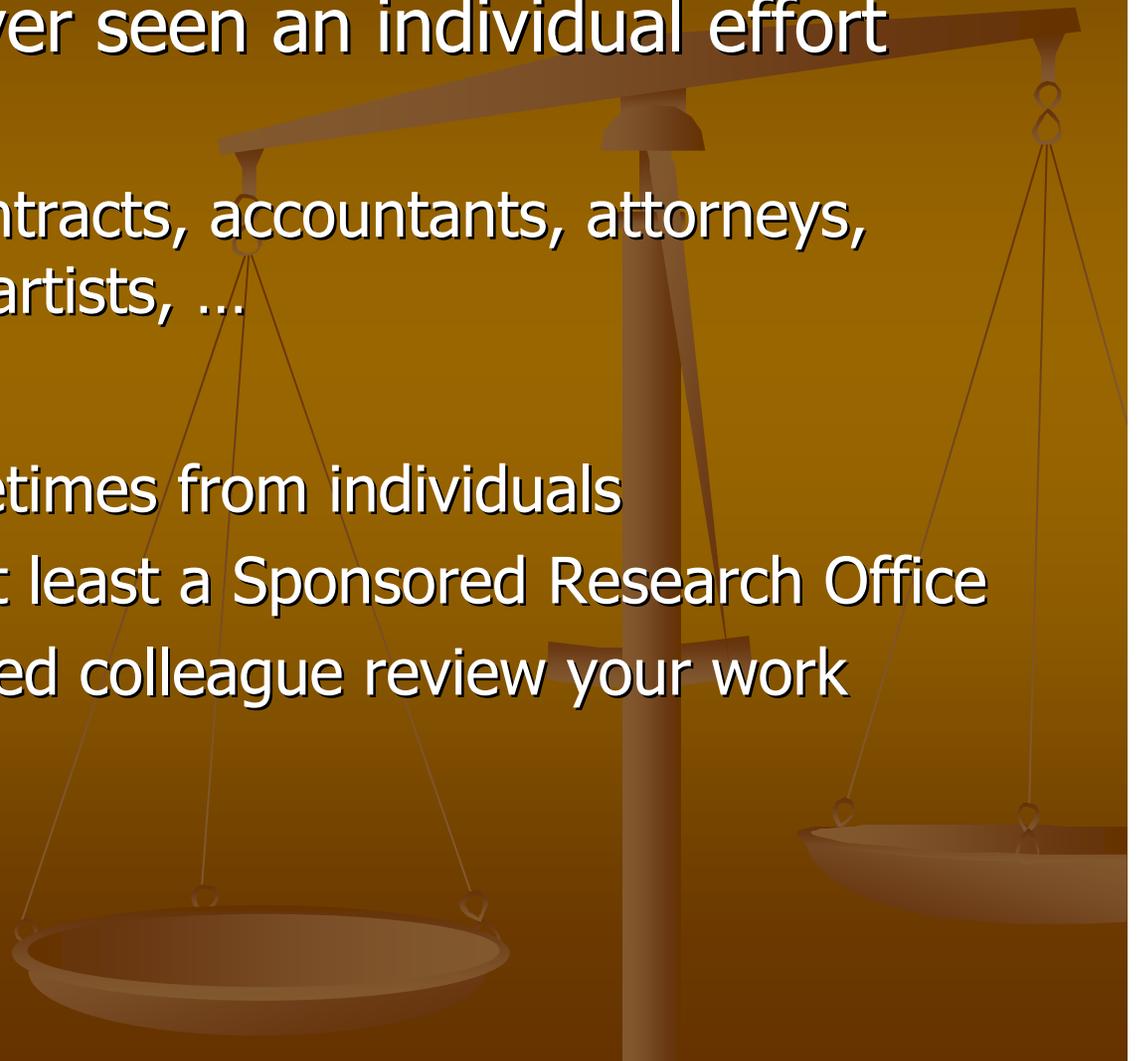
# Is It Right for Me?

- What Exactly Do I Want?
  - Money
  - Recognition
  - Other Resources
- Why Me?
  - Location
  - Expertise: past experience, novel ideas or approaches, track record
  - Matching interests
  - Resources



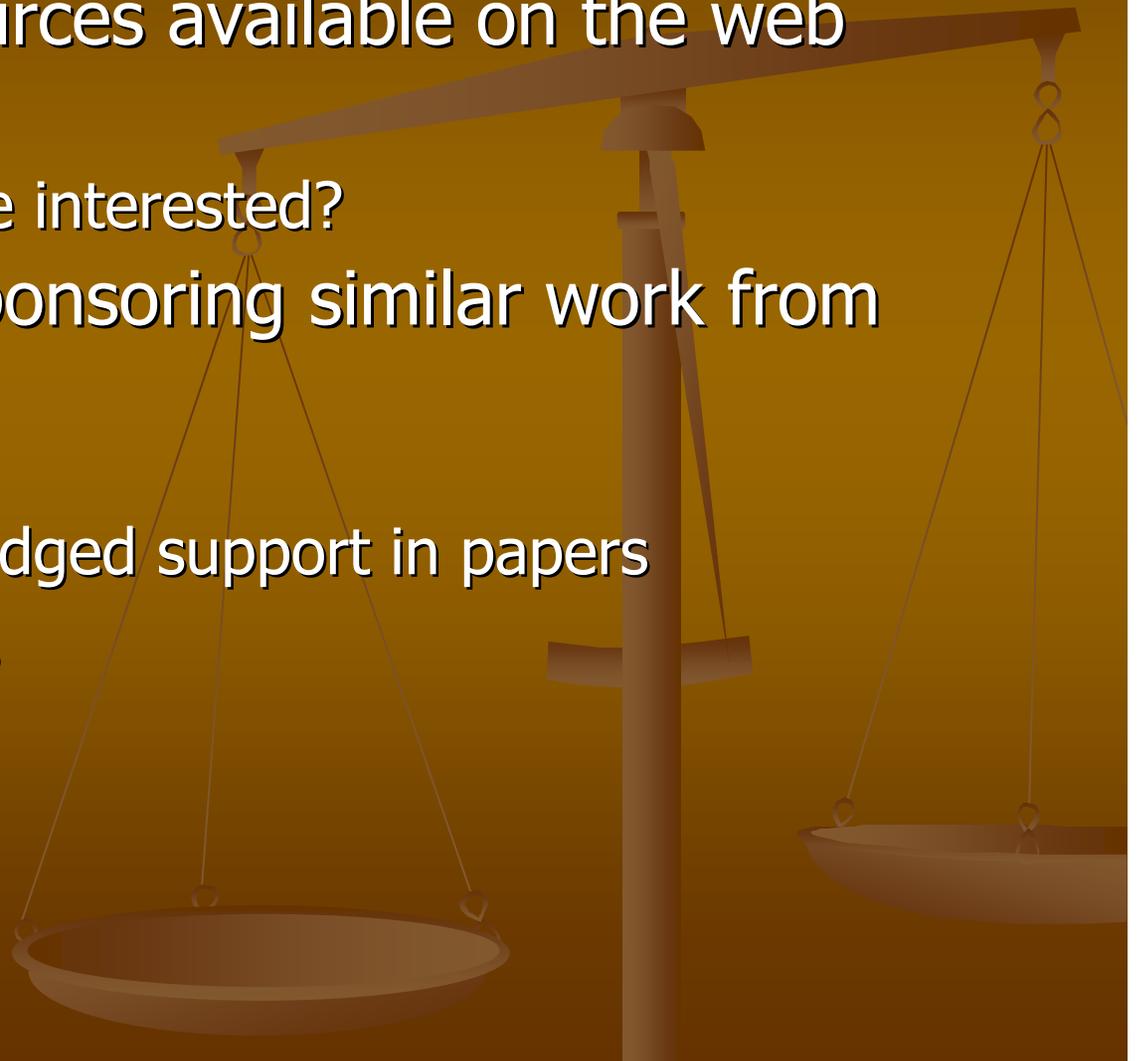
# Group/Individual Effort

- Industry—I've never seen an individual effort
  - Technical people
  - Support staff: contracts, accountants, attorneys, technical writers, artists, ...
- Academy
  - Small grants sometimes from individuals
  - Usually involves at least a Sponsored Research Office
  - At least let a trusted colleague review your work



# Identifying Sponsors

- Government resources available on the web
- Talk to sponsors
  - Who else might be interested?
- Find out who is sponsoring similar work from colleagues
  - Talk to them
  - Look for acknowledged support in papers
- Go to conferences
- Network!



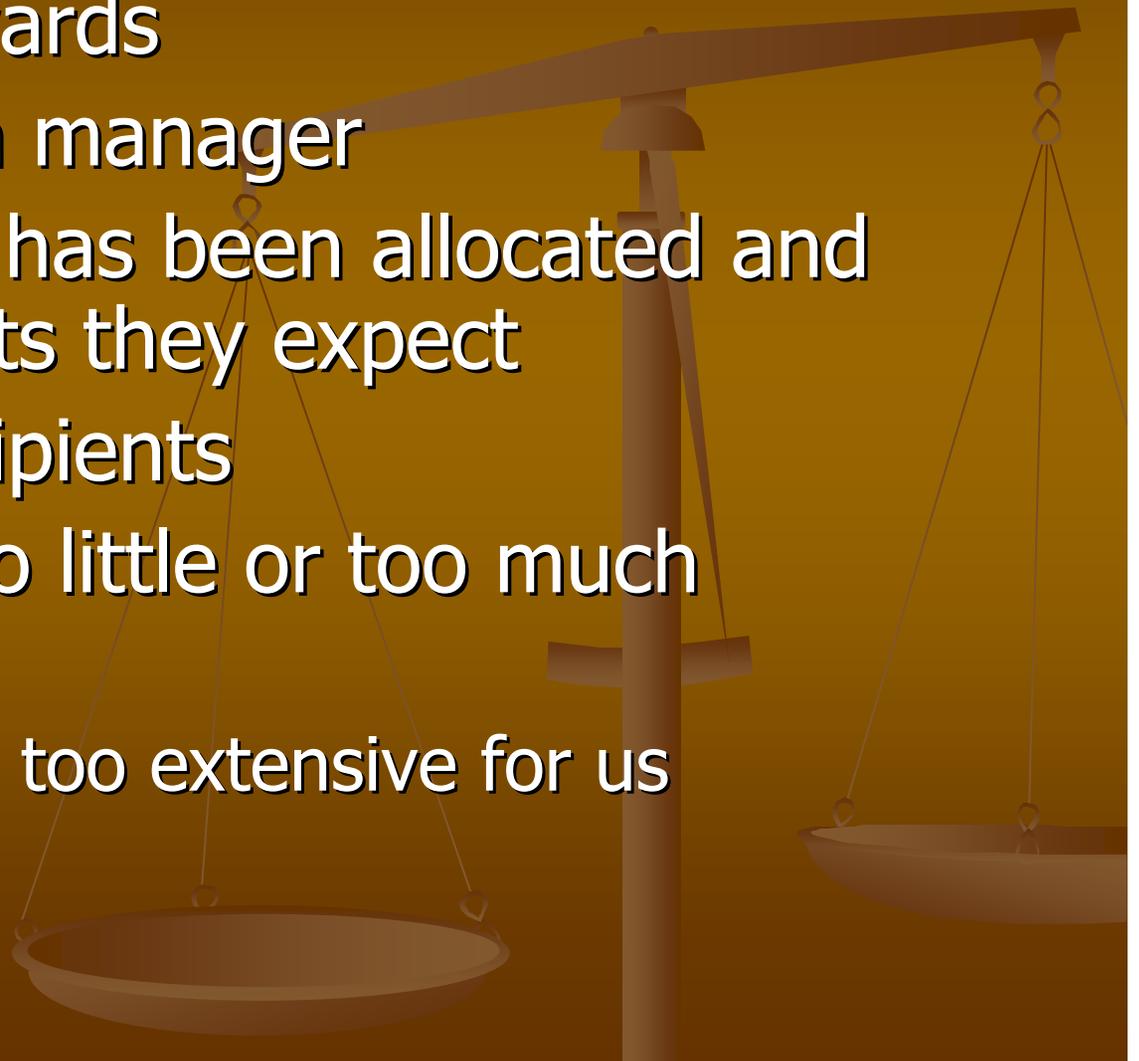
# AFOSR Example from BAA

This program involves experimental and theoretical research on the properties and interactions of atoms and molecules and forms the basic underpinning of a large range of technological applications in navigation, guidance, communications, atmospheric physics, low-and high-altitude nuclear weapons, effects phenomenology, directed-energy weaponry, and lasing mechanisms. Topics to be pursued include the following:

1. Trapping and cooling atoms and ions for high-resolution spectroscopy, studying cold-atom collisions, and developing advanced frequency standards.
2. Studying ultraviolet emission cross sections of atmospheric species by electron impact.
3. Observing interactions of atoms in strong electric, magnetic, and radiation fields.
4. Developing atomic physics fundamental to understanding plasma-enhanced deposition and microetching processes.
5. Understanding antiproton capture, confinement, transport, injection, and annihilation processes.

# Size of Awards (How Much Should I Ask For?)

- Look at past awards
- Talk to program manager
- Find how much has been allocated and how many grants they expect
- Talk to past recipients
- Don't ask for too little or too much
  - ILI Review
  - This program is too extensive for us



# Highlights

- Writing is crucial to success in physics
- Persuasive writing is important for technical success
- Key elements of success
  - Know your audience/requirements
  - Use strong language
  - Practice and get feedback

