The Broader Impacts Toolbox Workshop: Helping Researchers Effectively Meet the National Science Foundation Broader Impacts Criterion

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Outline

- Introduction and Disclaimer
- The Broader Impacts ‘Cosmo Quiz’: What is Broader Impacts?
- Case Studies
- The Broader Impacts Toolbox Workshop and Future Plans

My Background

- Associate Prof, University of Nebraska
- Research Areas:
  - Nanomedicine
  - Magnetism
- Synergistic Activities
  - Director, Project Fulcrum (GK-12)
  - RET mentor

Disclaimers

- I do not speak for the NSF
- Always check with your local program officer about specifics regarding Broader Impacts

So What am I Doing Here?

- Frustration
  - Time and effort spent on activities we know don’t work
  - Negative attitude toward education, outreach, etc. from colleagues
  - Concern about the future of the research enterprise
    - People
    - Budget (social attitudes toward science)
    - General happiness

The Broader Impacts "Cosmo Quiz"

Are you Compatible with the Broader Impacts Merit Criterion? Take the Cosmo Quiz and Find Out!

The Broader Impacts 'Cosmo Quiz'

Why did NSF institute the broader impacts merit review requirement

a) To make researchers' lives more difficult.

b) To help the NSF justify to Congress how their money is used.

c) To make researchers aware that they have responsibilities beyond producing *Science* and *Nature* papers.

d) To provide a fast, easy, check-off list that will streamline proposal review.

e) Broader Impacts are important to the overall survival of the research enterprise

The Broader Impacts 'Cosmo Quiz'

Which of the following are NOT broader impacts?

a) A researcher develops new programs for analyzing crystallographic data and maintains a website that helps people learn to use the programs.

b) A scientist works with her local science museum to develop an exhibit about the applied aspects of her research on spiders.

c) A researcher employs students from a minority-serving institution over the summer in his laboratory.

d) A researcher holds a conference to bring together experts in her field.

e) A researcher trains graduate students.

f) A researcher trains graduate students in interdisciplinary methods of materials research, allowing the students to gain experience in physics, chemistry and materials science.

g) A researcher sends one of his students for three months to work with an industry in a field related to the proposed research.

The Broader Impacts Criterion

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?

Why Broader Impacts?

- Improve scientific infrastructure
  - Increase number of domestic students pursuing STEM careers to maintain global leadership in STEM fields.
  - Improve/enhance education of STEM students (e.g. more interdisciplinary, improve communications & teamwork skills)
  - Science literate public required to support STEM funding and provide a highly trained scientific workforce
  - Disseminate research results and tools
  - Make the public (and Congress) aware of scientific advances that benefit them

Why Broader Impacts?

- Broaden participation
  - By 2050, Hispanics/Latinos are projected to comprise 24% of the total population and African-Americans will comprise 13%.
  - Continuing the historical under-representation of members of underrepresented groups (including women) in STEM fields will decrease further the talent pool from which STEM disciplines and industries can draw.

The Broader Impacts ‘Cosmo Quiz’

- True/False: Every research proposal must have an ‘education part’

The Broader Impacts ‘Cosmo Quiz’

- True/False: Every research proposal must have an ‘education part’
  - Some programs have a specific requirement for an ‘education’ portion
    - Centers
    - CAREER
  - BI is NOT ‘an education part’

The Broader Impacts ‘Cosmo Quiz’

- T/F: BI requires me to do something with K-12 and the general public.

The Broader Impacts 'Cosmo Quiz'

- T/F: BI requires me to do something with K-12 and the general public.
  - NSF Lists are *examples* : you don't have to do something in every category
  - K-12 is one option, not a requirement
  - Don't do something that doesn't make sense within the context of your project.

Common Misconceptions about BI

- Broader Impacts are restricted to education and outreach activities
- BI includes:
  - technology transfer
  - science policy
  - developing instrumentation that will benefit your research community
  - broadening participation in STEM fields
  - establishing user facilities
  - ...and more.

Broader Impacts ‘Cosmo Quiz’

- T/F: BI requires me to do something novel, just like the research I propose

Broader Impacts 'Cosmo Quiz'

- T/F: BI requires me to do something novel, just like the research I propose
  - There is no explicit requirement that BI activities be new or innovative
  - Adapting and building upon materials developed elsewhere is perfectly acceptable
  - Build upon others' success

Broader Impacts ‘Cosmo Quiz’

- T/F: I can hire someone to do BI for me

Broader Impacts 'Cosmo Quiz'

- T/F: I can hire someone to do BI for me
- True (sort of)
  - Leveraging existing programs at your institution or within your discipline is encouraged
  - You can involve students, postdocs, etc.
- False (sort of)
  - BI should be integrated with *your* research
  - You must have some intellectual investment in the planning and execution of the project.

Broader Impacts 'Cosmo Quiz'

- T/F: I already do a lot of education and outreach work, so I shouldn't have to propose something new
  - BI is the broader impacts of the proposed research
  - BI needs to be connected to the proposed research program in some way

Broader Impacts ‘Cosmo Quiz’

- T/F: Developing a new course is part of a faculty members’ job and shouldn’t count as a Broader Impact

Broader Impacts Case Studies

Case Study: Informal Science

Centers are in a unique position to leverage their educational/outreach programs

- Liberty Science Ctr (LSC) & Princeton Ctr for Complex Materials (PCCM)
- 12 weekends of programming in conjunction with the opening of *Strange Matter*
- LSC staff developed a script
  - **Frame discussions between speakers (Princeton faculty and graduate students) and audience members**
  - **Promote audience participation**
  - **Speakers could use script, alter script, or develop presentations on other subjects**
- PCCM Education Director worked with presenters at Princeton prior to their appearances

Case Study: Informal Science

"Believe it or not, many of our scientists were nervous at first because this was a new audience for them, and we took away their traditional tools of communication, such as calculus, Power Point presentations and equations"

"Every scientist from PCCM who presented at Liberty Science Center came back very pleased with his or her experience."

Case Study: Informal Science

"Our guests were thrilled to speak with 'real' scientists...This kind of experience allows people to see scientists as people, not as the caricatures which tend to dominate their images in popular culture."

Case Study: Informal Science

Project opened doors for future BIs

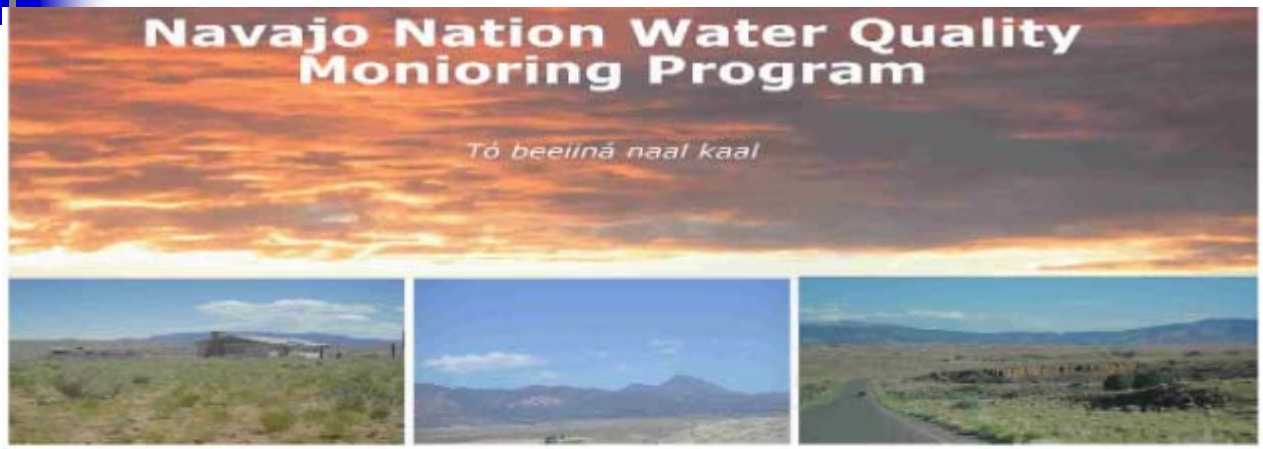
- Now that the collaboration is established, future activities are being written into grants
- PCCM is helping the science center pursue funding opportunities
- Individual scientists can ‘plug in’ to these opportunities

Find the BIs

ABSTRACT

Prof. Franz Geiger of Northwestern University will seek molecular level information on chromium species interacting with surface groups, with adsorbed and interfacial organic molecules, and water. Such knowledge is essential to achieve an understanding of the interactions of chromium with soil and model relevant aqueous/solid interfaces. This information is of great importance in dealing with a major environmental problem, namely the presence of toxic metals in soils and water.

Case Study: Individual PI



The Geiger group at Northwestern University in collaboration with Dr. Fred Begay, Program Coordinator for the Los Alamos National Laboratory and President of the Seaborg Hall of Science, has developed a multi-disciplinary program to study the water quality of drinking wells and springs near old uranium mines on the Navajo Reservation in the southwestern U.S.

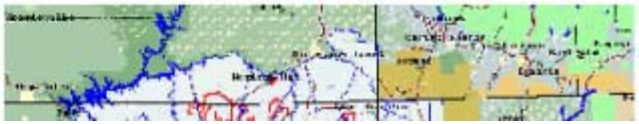
To Seach by names

CLICK HERE

To Search by map

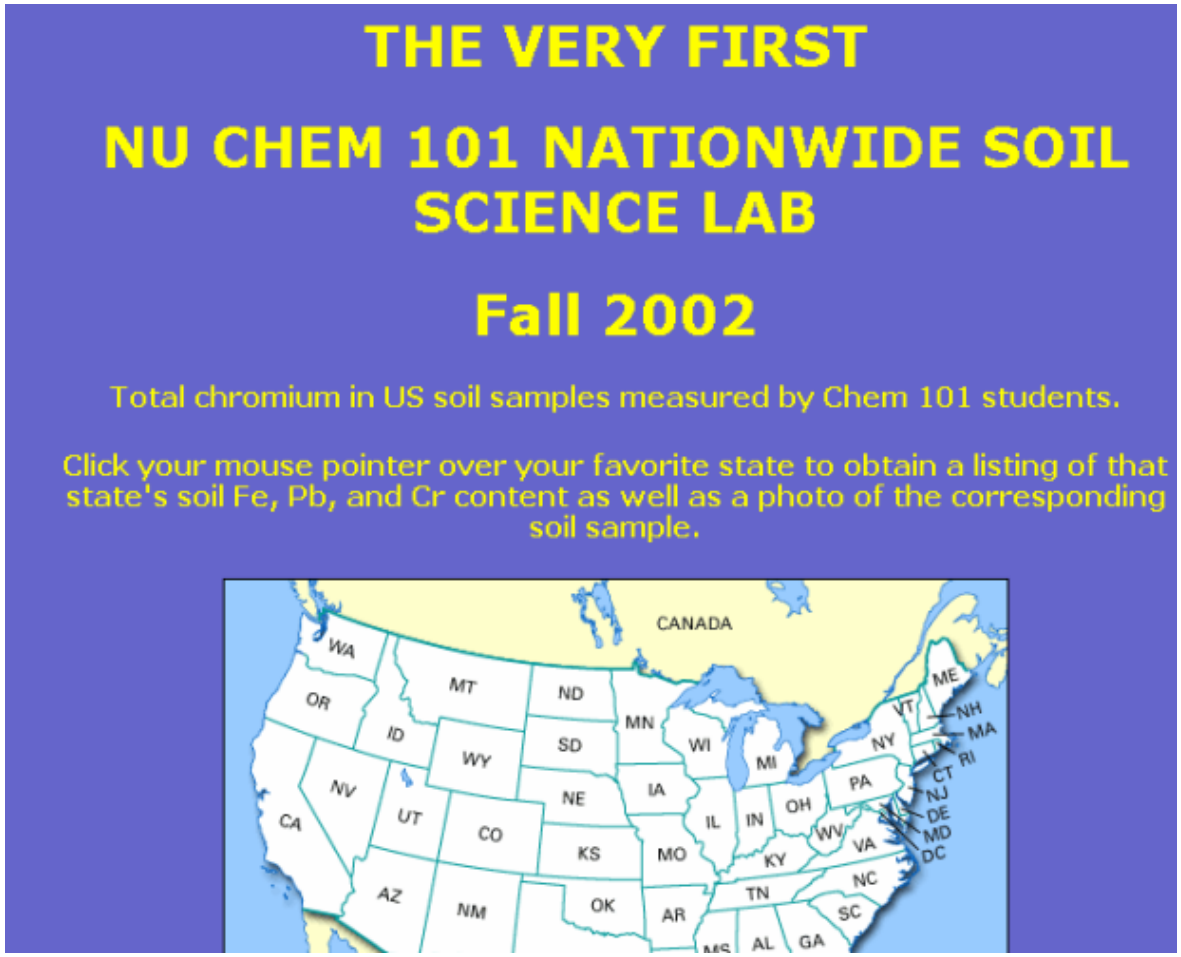
CLICK HERE

Black Mesa	Dennehotso	Rough Rock
Blue Gap	Dilkon	Round Rock



- **Effect of abandoned uranium mines on water**
- **Web-page dissemination of results**
- **Involves undergrads in research testing commercial water filters**
- **Provided a free pitcher filter for use by reservation residents and marketed program**

Case Study: Individual PI



- **Freshman chem students come from all over the U.S.**
- **One group of students has their parents send soil samples from home.**
- **A second group collects soil samples locally**
- **Samples analyzed for Fe, Cr and Pb using ICP-mass spectrometry.**
- **Web dissemination of results**
- **Shows societal applications of chemistry**
- **Relates coursework to ‘real life’**

Case Study: Multiple Individual PIs

Physical Chemistry at the Nanometer Scale [PC@nm]
KW Hipps, Washington State University
Award # CHE-0138409 & 0234726

Scanning probe microscopy facilities and instructors with expertise derived from individual NSF grants were key elements in the success of the 2003 PC@nm summer school in Pullman Washington. Ten internationally recognized specialists in nanoscience donated their time to provide an extremely intensive (10 day) sequence of lectures and laboratory demonstrations to 62 students from the US and 9 from abroad. The conference was organized by K W Hipps and the Petroleum Research Fund provided direct financial support. See http://www.wsu.edu/~nano/ and *J. Chem. Ed.* 2005, *82*, 693-742 for details. Shown here is a subset of the instructors and students during the final banquet on Lake Coeur d'Alene.

Instructors: S. Buratto, J.T. Dickinson, Robert Hamers, KW Hipps, Jan Hoh, Stuart Lindsey, Calvin Quate, Otto Sankey, N.J. Tao, and Henry White.

- **Intensive workshop for students, postdocs in scanning probe microscopy**
- **Brings together individually funded investigators**
- **Supplemented with PRF funding**

Find the Broader Impacts

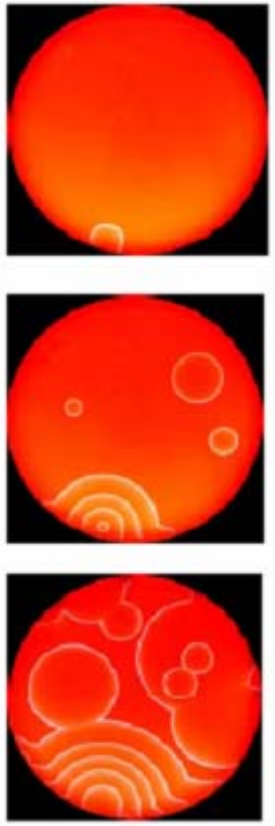
… experimental and computational research in nonlinear chemical dynamics, focusing on creating and understanding a variety of new phenomena involving … pattern formation in reaction-diffusion systems. Four areas will be explored. First, the behavior of oscillating chemical reactions in water-oil-surfactant microemulsions will be examined; Next, external light source perturbation will be used to probe Turing patterns, standing waves, and cluster patterns in the chlorine dioxide- iodine-malonic acid reaction, to seek new forms of resonant behavior and to study the facts of growth on pattern formation. …efforts will be undertaken to develop a systematic understanding of "chemical optics," the behavior of various types of chemical waves involving reflection, refraction, diffraction, and interference. Finally, new systems for pattern formation studies will be developed.

Research outcomes will have potential applications to biology, catalysis, and information processing. As well, these phenomena are aesthetically appealing, and demonstrations and presentations can interest a wide range of scientific and lay audiences. Pattern formation in chemistry is a central problem in modern macroscopic chemical kinetics. Reaction-diffusion systems constitute the most convenient analog models for pattern formation in neurobiology, catalysis, and ecology, and are useful for information processing.

Case Study: Individual PI

Irving R. Epstein
Brandeis University
CHE-0306262

One aim of this research project on nonlinear chemical dynamics is to design and to analyze "simple" chemical systems that constitute analogs of memory formation and processing in living systems. PI Irving Epstein serves on the scientific advisory board of the Flaschner Judicial Institute, a non-profit organization that conducts educational programs for Massachusetts judges. In collaboration with the judge who chairs the board, he organized and spoke at a full-day symposium, attended by about 30 judges, on "The Science Behind Memory". Presentations by scientists included such topics as chemical changes that take place in the brain when memories are formed, functional magnetic resonance imaging (MRI), and the reliability of eyewitness testimony. The day concluded with a panel session in which judges, prosecutors and defense attorneys discussed the implications of what they had learned for courtroom practice in general and for several specific cases.



Developing waves in the Belousov-Zhabotinsky reaction

Hints for Effective BI

- Don’t re-invent the wheel
  - Look in the literature for what has been done and shown to ‘work’ by evaluation
  - Talk to other people on campus to see if you can leverage existing infrastructure and relationships (NSF-funded centers are good starting points).
- Don’t propose something you don’t have the skills and/or resources to do
  - Acquire skills, networks and expertise by collaboration
  - Include references in your proposal to demonstrate you know what has already been done.

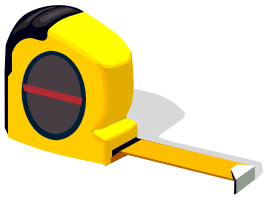
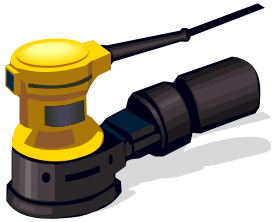
Hints for Effective BI

- Explicitly state the goal and expected results of your BI activity
  - Why are you doing it?
  - How does it integrate with your research?
  - If it ‘works’, how will you know?
- Evaluate your proposed activity
  - In research, we use papers and presentations to evaluate ‘good’ research
  - What are the signs that your activity is successful?

Hints for Effective BI

- Disseminate your results
  - Many scientific societies have sessions at which BI projects cab be presented
  - Help prevent others from re-inventing your wheel
- Talk to your program director *specifically* about BI
  - Interpretation/importance/expectations vary
  - Ask whether it is usual in your division to budget for BI
  - Read recently funded abstracts in the division to which you are proposing.

The Broader Impacts Toolbox

Broader Impacts Toolbox Workshop

- May 2005
- Pan Disciplinary
- Scientists, Education/Outreach Professionals, Professional Society Representative
- Goals
  - What resources exist to help scientists fulfill their BI responsibilities?
  - What resources need to be created to help scientists fulfill their BI responsibilities?
  - How do you make scientists and those working primarily in BI activities aware of these resources?

BI Toolbox Workshop Conclusions

- Clarify Expectations
- Centralize the BI Knowledge Base
- Organize the BI Community

BI Toolbox Workshop Conclusions

- A significant amount of researcher dissatisfaction arises from a widely held belief that the BI criterion is arbitrary, unclear and inconsistently applied.

- Few STEM researchers receive preparation for fulfilling the broader-impacts criterion. resources they could use to satisfy BI.

Action Items: Clarify Expectations

- The motivation behind BI and what qualifies as BI must be made explicit to applicants, reviewers and program officers.

Action Item 1: Develop a Frequently-Asked-Questions-format document that clarifies the motivation behind BI and what is expected from applicants.

Action Item 2: Encourage and facilitate community conversations about BI to encourage disciplines to explore how broader impacts applies to their communities.

BI Toolbox Workshop Conclusions

- Community Discussions are Needed
  - How do Broader Impacts relate to our specific scientific community?
  - Are there unique ways we can emphasize Broader Impacts in our community?
  - Are there particular models that would best serve the needs and interests of the community (i.e. brokers, center- or institution-level coordinators)?
  - What should we be doing as a community to facilitate Broader Impacts?

BI Toolbox Workshop Conclusions

- Few STEM researchers receive preparation for fulfilling the broader-impacts criterion. resources they could use to satisfy BI
- There are few easily accessible resources for researchers seeking to fulfill the BI criterion
  - Evidence of ‘what works’
  - Information on what others have done
  - Few mechanisms for sharing information

Action Items: Knowledge Base

- Develop and disseminate a researcher-friendly, easily accessible BI knowledge base ('Toolbox').

Action Item 3: Develop a Broader Impacts Toolbox to localize information for researchers and others.

Action Item 4: Develop a template that can be adapted for different disciplines and used to disseminate the tools via workshops.

BI Toolbox Workshop Conclusions

- Centralize/Disseminate the BI Knowledge Base
  - What's been done?
  - What works?
  - How do we know?
  - Where can I go for help?
- Needs to be focused and easily accessible to scientists
- A workshop template needs to be developed that can be modified and used with different communities

Action Items: The Toolbox

- Addresses
  - What's been done?
  - What evidence is there that it works?
  - How was it done?
  - Where can I share my results?
  - Who else is interested in this topic?
- Must be:
  - Targeted
  - In the language of researchers
- Could be a bridge between education research and researchers

Action Items: The BI Community

- An increasing number of people have BI as a significant part of their professional responsibilities.

Action Item 5: Hold workshops to disseminate models of how institutions, disciplinary groups and regional networks can help researchers optimize the broader impacts of their research.

Action Item 6: Support networking opportunities for those active in BI. Facilitate sharing evaluation data, management tools, and other resources.

BI Toolbox Workshop Conclusions

- A growing number of people have BI-type activities as a significant portion of their job responsibilities
  - Examples: Professional research managers, education/outreach coordinators, faculty with responsibilities in teacher preparation
  - There is no established career path
    - Reward structure
    - Permanency
    - Advancement
    - Recognition of work quality
    - Need for networking and sharing resources

A Warning

- Applicants have a built-in motivation to fulfill the BI criterion
- If referees do not apply the BI criteria equitably, applicants will continue to feel frustrated
- Ultimately, this lies in the hands of Program Directors